Chairperson: Bob Wyatt, NW Natural
Treasurer: Frederick Wolf, DBA, Legacy Site Services for Arkema

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Via electronic mail

Amy Legare
Chair, National Remedy Review Board
United States Environmental Protection Agency
One Potomac Yard (South Building)
2777 S. Crystal Drive
Arlington, VA 22202
legare.amy@epa.gov

c/o Kristine Koch
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900, M/S ECL-115
Seattle, WA 98101-3140
koch.kristine@epa.gov

Re: LWG Recommended Approach to Portland Harbor Cleanup Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240

Dear Ms. Legare,

On September 18, 2015, EPA invited the Lower Willamette Group (LWG) to provide feedback to the National Remedy Review Board (NRRB) on the remedy selection for the Portland Harbor Superfund Site, including "any recommended approach for site cleanup."[1] The LWG appreciates the opportunity to provide these comments to the NRRB.

The LWG is composed of the ten parties who signed agreements with EPA to conduct the remedial investigation and feasibility study (RI/FS) of the Portland Harbor and four other parties who have contributed financially to the project.[2] The LWG, a small subset of potentially responsible parties identified by EPA, has been working with EPA to complete the RI/FS of the site for more than 14 years.

EPA and the LWG have made significant progress toward characterizing environmental conditions and risks at the site. The LWG's goal is to work with EPA to move forward with a cleanup proposal that is effective, achievable, and consistent with the National Contingency Plan (NCP) and agency guidance. In addition, we agree with EPA that the cleanup should be focused "on those areas that have the highest levels of toxic and persistent contaminants and whose cleanup will have the most impact on reducing risks to human health and the environment."[3]

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[1] EPA 2015a
[2] The LWG is Arkema, Inc., Bayer CropScience, Inc., BNSF Railway Company, Chevron U.S.A. Inc., City of Portland, EVRAZ, Gunderson LLC, Kinder Morgan Liquids Terminals, NW Natural, Phillips 66 Company, Port of Portland, Siltronic Corporation, TOC Holdings Co., and Union Pacific Railroad Company. This letter was prepared in cooperation with and reviewed by Ramboll Environ.
[3] EPA 2015a

Despite the progress made, the RI/FS process has not been without its challenges. Substantive disagreements arose during the risk assessments. More recently, EPA has rewritten the RI and FS. As it stands, the current draft of the Portland Harbor FS (the EPA FS) lacks some critical information needed for remedy selection. For example, the Portland Harbor FS must include sufficient information for an understanding of site conditions, as well as for making risk management decisions that prioritize the most significant and realistic risks at the site. It should also include a practical approach for identifying and managing "principal threat waste" (PTW) that does not identify vast areas of relatively low concentration, readily contained sediments as PTW. Finally, it should provide tools to evaluate and compare the effectiveness of remedial alternatives at reducing risk and achieving cleanup goals, along with the necessary backup to understand the alternatives evaluation.[4] It is critical that EPA make substantial revisions to the EPA FS so that is can be used for selection of a rational remedy.

Based upon our comprehensive study of the lower Willamette River and the Portland Harbor and our thorough knowledge of the physical, chemical, biological, and societal characteristics of the river, the LWG recommends the following approach to cleaning up Portland Harbor:

1. Focus on managing the most significant and pervasive risks.

   - Sediment cleanup levels should be tied to clearly articulated and accepted risk management goals. The FS, Proposed Plan, and Record of Decision (ROD) should document a direct correlation between active remedies (capping, dredging, in situ treatment, or enhanced monitored natural recovery [EMNR]) and important risks identified in the baseline risk assessments (BLRAs). Less significant risks, risks based upon less plausible exposure scenarios, and risks for which there is no clear correlation with sediment concentrations should not independently drive active sediment remedies. Benthic risks should be addressed consistent with the approved Baseline Ecological Risk Assessment (BERA).[5]

   - To optimize risk reduction, EPA should modify and realign the preliminary remediation goals (PRGs) and remedial action levels (RALs) to define sediment management areas (SMAs) so that remedial actions in these areas are transparently aligned with the BLRAs and more accurately reflect achievable risk-management goals.

   - EPA should work with other Portland Harbor stakeholders to identify functional opportunities for minimization of interim and short-term exposure to chemicals during the cleanup. For example, EPA could work with landowners on whether strategic locations of improvements to access to the river could encourage recreational or subsistence fishing in areas of lower sediment contamination. The community and potentially responsible parties could assist in the creation of innovative and scientifically grounded programs that provide interim measures to help mitigate risk from fish consumption and enhance site-specific data to better understand how to communicate effectively about risk.

   - EPA should acknowledge that any Portland Harbor sediment cleanup under consideration will not entirely eliminate risk. In particular, the cleanup will not remove fish advisories currently in place or achieve attainment of state water quality standards for the main stem Willamette River as a whole.

2. Reduce the uncertainty about natural recovery.

   - The LWG would like to meet with EPA and its modelling experts to better understand their concerns and to discuss potential refinements to or additional tests of the QEAFate model that might enhance EPA's confidence in the model's ability to predict natural recovery rates and the long-term effectiveness of the alternatives. EPA should work with potentially responsible parties now to conduct baseline monitoring to confirm declining contaminant concentrations in fish and sediment and reduce EPA's uncertainty about

[4] The LWG recently received the final section of the EPA FS on August 18, 2015. Consistent with EPA's instructions, the LWG submitted a list of significant comments on Section 3 and 4 of the EPA FS on September 8, 2015. LWG 2015c. The LWG's September 8, 2015 comments are enclosed with this letter for the NRRB's reference.

[5] Windward 2013

predicting long-term risk reductions through natural recovery. Surface sediment PCB data collected in 2014 in Portland Harbor[6] by non-LWG parties shows that concentrations have declined since the FS data set was closed.

- Pre-construction baseline data and other information collected during remedial design will further reduce uncertainty and help refine the model.

3. Improve the accuracy and transparency of the assumptions behind the remedial alternatives. Explain how additional risk reduction justifies higher cost actions.

    - EPA should not identify materials that can be reliably contained as “principal threat wastes.” Blanket identification of large areas of relatively low concentration (e.g., 200 micrograms per kilogram [µg/kg] PCBs) sediments as PTW is neither required by the NCP nor necessary to protect public health or the environment.

    - EPA should consider treatment of principal threat or other remediation wastes only where the treatment cost-effectively achieves greater risk reduction than other technologies or disposal options. The need for treatment of sediment destined for upland landfills should be based on the acceptance criteria of the upland facility. In situ treatment of “principal threat” materials should be required only if contaminants cannot otherwise be reliably contained.

    - Assigning and comparing technologies on a more localized and detailed spatial scale would allow EPA to demonstrate that its selected remedies will cost-effectively optimize risk reduction.

    - Our experience on sediment remediation projects in the Portland Harbor and elsewhere in the Pacific Northwest leads us to conclude that some of the key construction assumptions in the EPA FS (including assumptions about construction duration, impacts, risk, and cost) are inaccurate. Realistic construction assumptions are necessary to evaluate short- and long-term effectiveness and implementability. Accurate cost estimates are necessary to evaluate cost effectiveness. EPA’s assumptions must be transparent in order to support the negotiation of consent decrees to implement EPA’s selected remedy through a performance settlement.

4. Maximize flexibility in remedy design and implementation.

    - The FS and ROD should explicitly allow flexibility for refinement and adjustment of technologies and process options during remedial design.

    - EPA should divide the site into operable units (OUs) focused on the most important SMAs. Dividing the site into OUs would allow EPA to evaluate and compare technologies on a more localized and detailed scale and would facilitate the administrative implementability of the remedy.

    - EPA should consider the use of contingent remedies to address site-wide risks, as well as to address uncertainties within SMAs. Where significant uncertainty about the effectiveness of a technology at a particular SMA or the time frame to attain cleanup levels across an exposure area remains at the time of the ROD, contingent remedies, which are anchored in Oregon practice and explicitly supported by EPA guidance,[7] would allow EPA administrative and engineering flexibility to adjust to conditions at the site during remedy implementation.

Portland Harbor is a special place. It is Oregon’s largest seaport, located immediately north and downstream of downtown Portland, and occupies the lower reach of the Willamette River, the 13th largest river in the contiguous

[6] This data was presented to EPA and the Oregon Department of Environmental Quality (DEQ) by webinar on September 10, 2015.
[7] EPA 1999, Section 8.3

United States. The river is wide with large water flows, averaging 33,000 cubic feet per second. Portland Harbor is an active working harbor and at the same time supports invertebrate, fish, and wildlife communities, as well as human recreational and cultural activities (e.g., boating, fishing, and beach use), and serves millions of industrial, commercial, Tribal, municipal, and recreational users.

The LWG believes that this complex system can be efficiently cleaned up by focusing active remedies on discrete areas of Portland Harbor where contaminant levels present the most potential risk to humans, fish, wildlife and invertebrates. Segregating, prioritizing and sequencing the cleanup of these higher risk areas would streamline the negotiation of consent decrees for remedy implementation and get cleanup started faster

We appreciate the opportunity to provide these comments regarding a recommended approach for site cleanup. We understand EPA may include a description of its preferred cleanup in its materials to the NRRB, and the LWG would like the opportunity to review and share its perspective on that description with the NRRB. We would be happy to do so just before or even after the NRRB meets in Portland in November.

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Recommended Approach to Cleanup

The remainder of this letter explains our technical rationale for the recommendations above. Section 1 expands upon our recommendation to focus on managing the most significant and pervasive risks at the site by proposing that EPA tie sediment cleanup levels to risk management goals. Section 2 discusses information that should be reincorporated into the conceptual site model to address and adequately reduce EPA's uncertainty about natural recovery and the long-term effectiveness of the alternatives. Section 3 describes why it is critical that EPA improve the accuracy and transparency of the assumptions behind the remedial alternatives and explain how incremental risk reduction justifies higher cost actions. Section 4 provides technical recommendations for how EPA can optimize risk reduction on an SMA or OU-specific basis by incorporating flexibility in remedy design and implementation into the ROD. Section 5 presents the LWG's recommended remedy for Portland Harbor.

1. Focus on Managing the Most Significant and Pervasive Risks

The Portland Harbor baseline risk assessments identified potential risks by evaluating conservative exposure scenarios, often using detailed food web models.[8] The resulting risk calculations are, to varying degrees, uncertain. EPA guidance states that baseline risk assessment should include conservative analyses[9]; however, EPA's remedy selection should be developed on risk management goals that look beyond the baseline risk assessments to consider "site-specific conditions, including any remaining uncertainties on the nature and extent of contamination and associated risks."[10] In the risk management process, "the results of the risk assessment are integrated with other considerations, such as economic or legal concerns, to reach decisions regarding the need for and practicability of implementing various risk reduction activities."[11]

At sediment sites, EPA should carefully evaluate the assumptions and uncertainties associated with site characterization data and site models; select site-specific, project-specific, and sediment-specific risk management approaches that will achieve risk-based goals; and ensure that sediment cleanup levels are clearly tied to risk management goals.[12] The transparent application of risk management principles helps prevent the overstatement of risks, which could "force an active management solution that [would] not reduce risk and thus [would] be inappropriate."[13] Further, EPA must consider the extent to which its remedial goals are achievable through cleaning up sediments at the site.[14]

Contrary to these principles, the EPA FS[15] lacks a coherent risk management strategy and relies largely on qualitative analyses.[16] Since consumption of fish presents over 95% of the potential risk identified in the Baseline Human Health Risk Assessment (BHHRA),[17] one useful risk management approach would be to look at how each cleanup alternative measurably improves the amount of fish people can safely eat from Portland Harbor. This can be expressed in meals-per-month, which in turn can be translated into site-specific sediment PRGs.

Table 1 shows a meals-per-month analysis and comparison of the EPA FS remedy alternatives based on EPA's estimated time-zero (i.e., immediately after construction) surface-area weighted concentrations (SWACs). Table 1 shows that there is essentially no reduction in risk from PCBs associated with fish consumption for the child and nursing infant scenarios for all alternatives. Under current conditions at the site, in order to be protective of her infant as defined under EPA's risk assessment, a nursing mother should eat less than one meal per month of resident fish. Even after Alternative G is performed, a nursing mother should still eat less than one meal per month to protect her infant. Therefore, from a risk management perspective, no sediment cleanup at the site can achieve acceptable

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[8] The LWG's reservations about aspects of EPA's risk assessments are well documented and not repeated here. See, e.g., LWG 2012.
[9] CERCLA Baseline Risk Assessment Human Health Evaluation, *EH-231-012/0692 (June 1992)*
[10] *Role of the Baseline Risk Assessment in Superfund Remedy Decisions* (OSWER 9355.0-30, April 22, 1991)
[11] http://www.epa.gov/oswer/riskassessment/superfund_management.htm
[12] EPA 2005a
[13] NRC 2001, p. 171
[14] EPA 2005a, p. 2-15
[15] EPA 2015b
[16] One of the primary differences between EPA's FS and the LWG 2012 Draft FS is that EPA's FS evaluates monitored natural recovery only qualitatively. As discussed later in this letter, it is therefore not clear how EPA concludes that any of its alternatives is protective, or concludes that any one alternative is more effective in the long term than any other.
[17] Kennedy Jenks 2013

risk levels or improve rates of fish consumption related to the child and nursing infant scenarios, so these potential exposure scenarios are not useful for the comparison of the EPA FS alternatives.[18]

For the adult scenarios, there is no gain in PCB risk reduction for excess cancer at 10^{-6} (i.e., <1 meal per month now and <1 after construction of all remedies). For non-cancer endpoints, the gain is quite limited (<1 meal per month now to 2 meals per month for EPA's Alternative E and 4 meals per month for EPA's Alternative G). This marginal increase likely falls within the range of uncertainty for this analysis.

It is only the adult scenario for excess cancer risk at 10^{-4} where an increase in meals per month is expected. However, because these are time-zero values, post remedy natural recovery is expected to result in similar equilibrium sediment concentrations and similar net gains in meals per month for all of EPA's alternatives. Finally, the time-zero SWAC of 87 µg/kg is based on mostly pre-2010 data; sediment data collected in 2014 indicates the "current" SWAC may, in fact, be much lower (e.g., at or below the time-zero SWAC for EPA's Alternative B).

Table 1. Post-remedy Meals per Month Analysis[a]

		Adult[c]			**Child[d]**	**Nursing Infant[e]**
	SWAC[b] (µg/kg)	**Non-Cancer (HQ<1)**	**Cancer Risk < 10^{-4}**	**Cancer Risk < 10^{-6}**	**Non-Cancer (HQ<1)**	**Non-Cancer (HQ<1)**
Current (Pre-2010)[f] Conditions	87	1	3	<1	<1	<1
Alternative B	50	1	6	<1	<1	<1
Alternative E	32	2	9	<1	<1	<1
Alternative G	16	4	17	<1	1	<1
EPA estimates ALL the alternatives will eventually reach a steady state concentration between background and equilibrium.						
Equilibrium[g]	20	3	14	<1	1	<1
Background	9	6	25	<1	2	<1

Notes:
a) Meals per month are based on estimated PCB concentrations in a fillet tissue, multi-species diet (25% each of smallmouth bass, black crappie, carp, and brown bullhead). Fish tissue concentrations were estimated using the FS food web model spreadsheets assuming that the water concentration is equal to upstream (0.1049 nanogram per liter [ng/L]).
b) Site-wide sediment SWACs were estimated based on EPA's Draft FS.
c) Adult fish consumption assumes one meal is equal to 8 ounces. Cancer risks represent combined child/adult fish consumption.
d) Child fish consumption assumes one meal is equal to 4 ounces. Child fish consumption is only evaluated for non-cancer risks.
e) Nursing infant represents the number of meals (8 ounces) that the mother could consume and not exceed the target risk level for the infant. The nursing infant scenario is only evaluated for non-cancer risks.
f) The Site Characterization and Risk Assessment (SCRA) database includes data collected through February 4, 2011. EPA has since added a few data sets to the FS database but they do not substantially refine the site wide SWACs presented in this table (e.g., Gasco Engineering Evaluation/Cost Analysis [EE/CA] data as provided by Anchor QEA in 2013 and Arkema EE/CA data as provided by Integral in May 2014).
g) The site-wide median value shown is based on the detailed assessment submitted to EPA: "Sediment Equilibrium Estimates for the Revised Feasibility Study."[19]

EPA's reliance on primarily qualitative evaluations in its FS precludes a practical assessment of the differences in short- and long-term risk reduction among the alternatives. EPA acknowledges that natural recovery is an important component of any remedy and is especially important for evaluating long-term changes in risk. However, EPA abandons any attempt to evaluate effects of natural recovery on SWACs (the key metric of risk in the EPA FS) and

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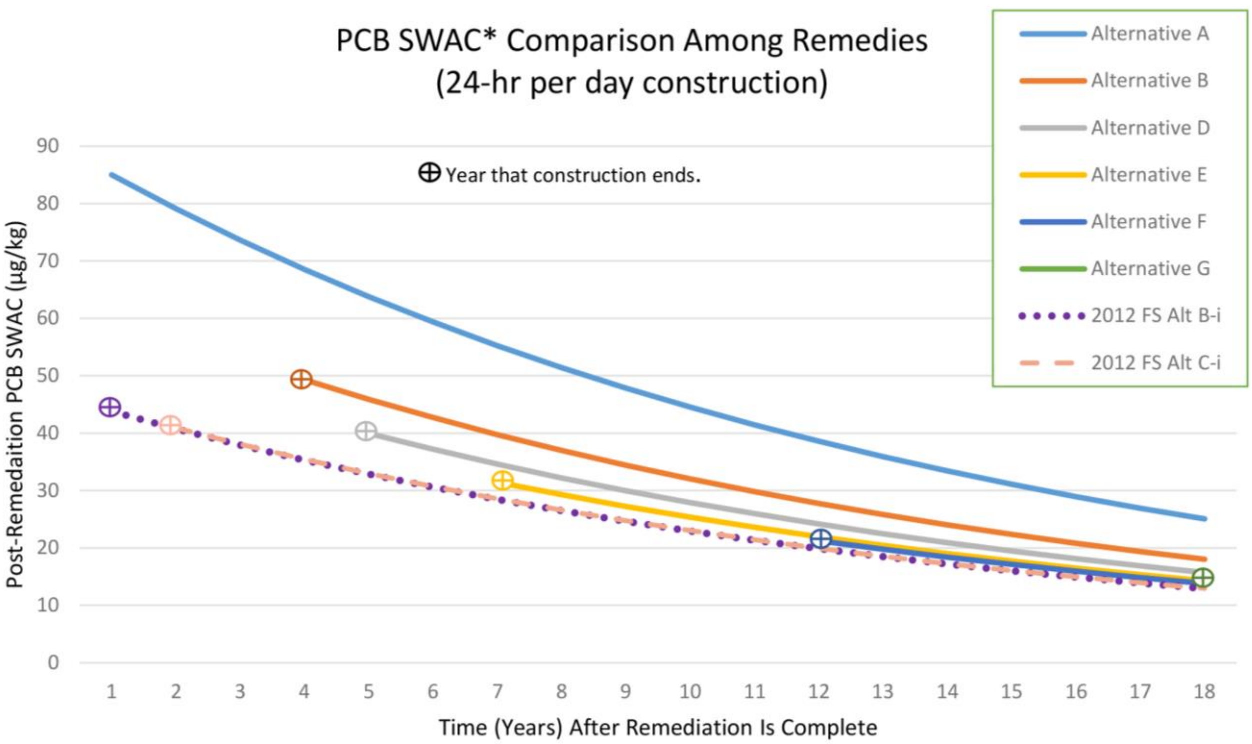
[18] This discussion focuses on risks from PCBs, which account for more than 90% of potential risk from fish consumption at Portland Harbor on a site-wide basis. Even less measurable risk reduction can be attained for other COCs.

[19] LWG 2014b

restricts risk reduction evaluation to the direct and immediate effects of construction. The effect of this omission is especially prominent when PCB SWACs are compared beyond the very short-term risk management horizon corresponding to construction completion.

For example, Figure 1 and Table 2 present EPA's estimated SWACs over time, after construction is complete using EPA's construction durations, as well as estimated SWACs based on two alternatives from the LWG 2012 Draft FS.[20] The lines show estimated decreases in SWACs using empirical data, not modeling estimates (i.e., the observed decline in smallmouth fish tissue PCB concentrations sampled over the period from 2002 to 2012). It is apparent that as soon as 11 years post-construction for Alternative E and 6 years for Alternative G, differences in SWACs among the active alternatives (i.e., B through G) are minor; total PCB SWACs range from about 13 µg/kg for Alternative G (RAL = 75 µg/kg) to 19 µg/kg for Alternative B (RAL = 1,000 µg/kg). This small range in SWACs likely does not represent a significant difference in risk for human consumers of resident fish taken from the Harbor.[21] Further, the small range in SWACs may not even be reliably detectable, given the variability observed in sediment PCB concentrations in the site. This lack of difference is especially important in evaluating EPA's alternatives, given that the key feature that EPA varied among the alternatives (e.g., the RAL) does not appear to affect long-term effectiveness in terms of risk reduction.

Figure 1. PCB SWAC Comparison among Remedies



*SWACs are estimated based on applying RALs for all COCs (i.e., based on remediation of the entire active remediation area).

[20] Estimated SWACs for LWG 2012 Draft FS calculated using RALs of 1000 µg/kg PCB, 1000 µg/kg DDE and 20,000 µg/kg BaPEq (2012 FS Alt B-i) and 750 µg/kg PCB, 1000 µg/kg DDE and 15,000 µg/kg BaPEq (2012 FS Alt C-i). One important difference between the EPA FS and the LWG 2012 Draft FS is that the LWG 2012 Draft FS applies RALs only in exposure areas determined by the baseline risk assessment to present unacceptable risk. The starting point of each line represents the time of construction completion. As discussed below, our experience from dredge projects in the Pacific Northwest suggests that EPA's construction duration assumptions are overly optimistic.

[21] This analysis is conservative (estimates slower natural recovery) because it does not include recovery that would take place before construction is started and during construction. This figure is not intended to represent the best interpretation of the long-term outcome and time to meet RAOs for the site. However, it illustrates, using EPA's information and stated concern about evaluation uncertainties, that EPA's conclusions regarding larger alternatives meeting the RAOs more quickly are based on unsupported assumptions.

Table 2. PCB SWACs (µg/kg) Comparison Using EPA's 24 hour/day Assumption for Alternative Durations

Alternatives	Years																	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
A (no action)	85	79	74	69	64	59	55	51	48	45	41	39	36	33	31	29	27	25
B				49	46	43	40	37	34	32	30	28	26	24	22	21	19	18
D					40	37	35	32	30	28	26	24	22	21	19	18	17	16
E							31	29	27	25	24	22	20	19	18	16	15	14
F												21	20	18	17	16	15	14
G																		15
2012 FS B-i	44	41	38	35	33	31	28	26	25	23	21	20	19	17	16	15	14	13
2012 FS C-i		41	38	35	33	31	29	27	25	23	21	20	19	17	16	15	14	13

Notes:

= Duration of alternative construction

= Year construction is completed and EPA estimated SWAC at that time.

= Year that alternative achieves the Alternative G post construction SWAC, plus 20% (i.e., plus or minus 20% is the EPA acceptable analytical accuracy for organic compounds) using estimated natural recovery rate.

These analyses are based on site-wide SWACs. The LWG recognizes that fish consumption risks also occur on smaller scales and agrees with EPA that active sediment remediation in areas exhibiting higher concentrations of contamination can measurably reduce risk. However, as demonstrated above, there is almost no discernable difference in the overall reduction of risk for remediation of areas defined by any one set of RALs compared to another, and the time to achieve this reduction is essentially the same for all of EPA's alternatives.

1.1 Adopt Cleanup Goals that Can Be Achieved by the Sediment Remedy

The successful implementation of remedial actions at contaminated sediment sites is contingent upon selecting cleanup levels—including Remedial Action Objective (RAOs) and levels based on appropriate or refined PRGs—that are attainable and sustainable via a sediment remedy. As stated in EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, when project managers are developing and selecting RAOs (and cleanup levels, which are the numeric expression of the RAOs), they "should evaluate whether the RAO is achievable by remediation of the site or if it requires additional actions outside the control of the project manager."[22] It is paramount that RAOs, and cleanup levels that are the numeric expression of the RAOs, "reflect objectives that are achievable from the site cleanup."[23]

Portland Harbor, the upstream watershed, and upland areas house commercial and industrial operations. In such settings, EPA guidance indicates that "it is typically very important to include…ongoing sources in the evaluation of what sediment actions may or may not be appropriate and what RAOs are achievable for the site."[24] EPA's FS considered background concentrations in the development of PRGs.[25] The LWG agrees that cleanup levels should not be below background.

[22] EPA 2005a, p. 2-15
[23] EPA 2005a, p. 2-15
[24] EPA 2005a, p. 2-21
[25] EPA 2015b, Section 2.2.2

However, the LWG continues to disagree with EPA's calculation of background Contaminant of Concern (COC) concentrations.[26] Through various statistical analyses of upstream bedded sediment and incoming suspended sediment concentrations, the LWG has identified a range of background or equilibrium concentrations.[27] The identification of a single background value by EPA for each chemical constituent oversimplifies the analysis of background and ignores the complexity of the natural environment where chemical concentrations are not represented by a single value and, instead, are represented by concentration ranges. EPA's dispute resolution document on background helps explain why EPA needs to evaluate what is considered anthropogenic background:

> [T]he purpose of the background analysis was to assess the likely sediment that comes from the larger Willamette watershed and…the analysis was not confined to assessing potential loading from the reference area only.[28]

EPA further acknowledges the wide range of potential chemical sources and concentrations, particularly in the large and complex watershed that feeds into the Willamette River:

> There are sources of contamination outside of the Site—both upriver of the Site and within the downtown reach—that may affect the ability of cleanup efforts within the Site to equilibrate to the selected cleanup levels regardless of whether the cleanup level is based on risk, regulatory standard or background.[29]

EPA's dispute resolution acknowledges that EPA's upriver background values are unattainable due to regional sources (throughout the 11,500 square miles of Willamette River watershed); therefore, those values cannot be achieved by the sediment remedy for the site. It remains to be seen if or how EPA will incorporate these factors into developing achievable cleanup levels. We continue to urge EPA to express background sediment concentrations as ranges (e.g., 6 to 19 µg/kg with outliers removed, and 14 to 60 µg/kg for the full data set for PCBs)[30] and fully consider equilibrium (e.g., calculated to be a median of 20 µg/kg PCBs and in the range of 7 to 35 µg/kg using empirical lines of evidence).[31]

1.2 Adopt PRGs that Address Realistic Risks from the Risk Assessments

The most important and pervasive risks should be a product of risk assessments conducted in accordance with EPA regulations and guidance. As described in the preamble to the NCP,[32] one of the policy goals of the Superfund program is to protect "reasonable maximum," but not "worst-case," individual exposures.

> EPA developed the concept of reasonable maximum exposure [RME], which is designed to include all exposures that can be reasonably expected to occur, but does not focus on worst-case exposure assumptions.[33]

The reasonable maximum exposure (RME) is the highest exposure that is *reasonably expected* to occur at a Superfund site. Exposure assumptions should…

> …result in an overall exposure estimate that is conservative but *within a realistic range of exposure*. Under this policy, EPA defines "reasonable maximum" such that only potential exposures that are likely to occur will be included in the assessment of exposures. The Superfund program has always designed its remedies to be protective of all individuals and environmental receptors that may be exposed at a site; consequently, EPA believes it is important to include all reasonably expected exposures in its risk assessments.[34]

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[26] EPA 2015d
[27] LWG 2014a, 2014b
[28] EPA 2015d, p. 16
[29] Id.
[30] EPA 2015b
[31] LWG 2014b
[32] NCP Preamble, 55 FR 8710
[33] Id.
[34] Id., emphasis added

In addition to evaluating the risks to the RME individual, EPA evaluates risks for the central tendency exposure (CTE) estimate, or average exposed individual. This approach is consistent with the Risk Characterization Policy and Handbook.[35] CTE estimates give the risk manager additional information to consider while making decisions concerning potential current or future site risks. The NCP is clear that the likelihood of exposure actually occurring (whether an RME or CTE estimate) should be considered when deciding an appropriate level of remediation.

> EPA does agree…that the likelihood of the exposure actually occurring should be considered when deciding the appropriate level of remediation, to the degree that this likelihood can be determined. The risk assessment guidance referenced above is designed to focus the assessment on more realistic exposures.[36]

Nonetheless, the EPA FS does not discuss the likelihood of the RME-based PRGs, nor how the potential for exposure plays into the appropriate level of remediation for this site.[37]

1.2.1 Baseline Human Health Risk Assessment

By focusing on worst-case scenarios, EPA's FS develops PRGs that represent maximum exposures estimated in the BHHRA and thus are inconsistent with EPA guidance. This section discusses four of the key technical deficiencies in the EPA FS use of the BHHRA to develop PRGs, PTW thresholds, and to support the remedy selection process. We then suggest a more technically sound approach to PRG development.

1.2.1.1 Fish and Shellfish Consumption Rates

The BHHRA evaluates fish consumption risks in RME and CTE scenarios intended to represent Tribal, subsistence, and recreational fish consumption within Portland Harbor. The EPA FS does not consider the assumptions and uncertainties associated with the RME and CTE scenarios, including whether they are *possible* or even *plausible* within Portland Harbor (e.g., the BHHRA states, "*The cancer estimates represent upper-bound values, and the EPA is reasonably confident that the actual cancer risks will not exceed the estimated risks presented in the BHHRA*"[38]). The following analysis demonstrates why the BHHRA fish consumption CTE scenario is more representative of an appropriate RME scenario and, therefore, more reasonable for PRG development.[39]

- **The Tribal Fishing Scenario** assumes adults consume 281 meals per year based on the 95th percentile of fish and shellfish from the Columbia River Inter-Tribal Fish Commission (CRITFC) survey.[40] The EPA FS does not consider the following when developing tribal fish consumption PRGs:

  – The BHHRA overestimates exposures to the site by assuming Tribal fishers harvest and consume fish *only* from Portland Harbor. In fact, contrary to this assumption, the BHHRA indicates that no CRITFC respondents reported consuming resident fish from the Willamette River, and only about 4% reported consuming anadromous fish from the river. Where consumption rates for a larger resource are used to evaluate a small part of the resource, a fractional intake term should be applied.[41]

- **The Subsistence Fishing Scenario** assumes adults consume 228 meals per year from the site. This subsistence-scenario fish consumption rate is the 99th percentile of fish and shellfish consumption rate

[35] EPA 2000a
[36] NCP Preamble, 55 FR 8710
[37] Furthermore, the EPA FS does not discuss how various risk drivers contribute to PRGs. For example, the EPA FS ARARs include maximum concentration levels (MCLs) and Secondary MCLs as water quality standards. In a river where water pre-treatment is required for municipal drinking water, the goal to achieve MCLs or Secondary MCLs in the river reflects poor risk management. Leaving aside the questionable ability of achieving MCLs or Secondary MCLs in an urban river of the scale of Portland Harbor, achieving these goals is unlikely to reduce water treatment plant operation costs because pre-treatment will continue to be required for other chemical constituents.
[38] Kennedy Jenks 2013, p. 4
[39] Notably, each of the risk assessment scenarios discussed assumes fish consumption at this rate from the Site for 30 years for the non-cancer assessment and 70 years for the cancer assessment
[40] CRITFC 1994. This survey included 513 interviews conducted at four Columbia River Basin tribal reservations (Nez Perce, Warm Springs, Yakama, and Umatilla).
[41] EPA 1989

from all sources—self -caught and purchased—throughout the United States.[42] The EPA FS does not consider the following in developing the subsistence fishing PRGs:

– The EPA[43] fish consumption estimate is based on consumption of all fish and shellfish (marine, estuarine, and freshwater) that are either self-caught or purchased at a store. The 228 meals-per-year value is a high-end value from that analysis and is not a site-specific consumption rate. It is not an appropriate basis for determining site risks or cleanup. Using the 99th percentile is not only unreasonable but also inconsistent with EPA policy and guidance.[44]

– The BHHRA asserts that the degree of consumption of shellfish from the site is uncertain, but site-specific data indicate that ingestion of self-caught shellfish is resource-limited.[45] The predominant species present is an invasive non-native clam that is illegal to possess. Crayfish are also present only to a limited degree. Thus, using the 99th percentile consumption rate for shellfish from all sources (including grocery-store purchased fish) overestimates potential site-related risks.

- **The Recreational Fishing Scenario (RME):** The RME estimate assumes 79.6 meals per year from the site based on the Adolfson[46] creel survey in which 28 of 91 anglers interviewed indicated they consume fish from the Columbia Slough; Columbia Slough is not part of the site. The specific rate applied in the BHHRA was the upper 95% upper confidence limit (UCL) for those consuming more than 50% of the weight of the fish. Details from Adolfson[47] are incomplete, but this appears to be based on a small subset (7 individuals) who reported that they consume the whole body of the fish. EPA's FS does not consider the following in developing the recreational fisher PRGs:

  – Using a dataset from a small population adds uncertainty to the estimate and does not support an RME.

  – Using the specific consumption rates based on consumption of the whole body of fish, rather than fillets, and including fish from areas outside of Portland Harbor, overestimates risks for most recreational anglers, supporting a worst-case scenario rather than an RME.

- **Recreational Fishing Scenario (CTE):** The recreational CTE scenario assumes adults consume 28 meals per year from the site and represents the 90th percentile of fish and shellfish from all sources, including the grocery store.[48] Consequently, this consumption rate does not, by definition, represent the central tendency of fish and shellfish from the site. Instead, a CTE is closer to the 50th percentile of self-caught fish from a representative resource.[49] Thus, the CTE used in the BHHRA more likely represents the RME for recreational anglers.

1.2.1.2 Nursing Infant Scenarios

EPA's FS relies on the nursing infant scenario to establish sediment PRGs.[50] This scenario is based on overly conservative exposure calculations that do not realistically estimate or represent infant exposures at Portland Harbor. Relying on this worst-case and unprecedented scenario is inconsistent with EPA and NCP guidelines and should not form the bases of PRGs and site-specific risk management approaches.

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[42] EPA 2002a
[43] EPA 2002a
[44] EPA 1989; EPA 2000a. In the NCP (1990, 55 FR 8710) preamble, EPA says: The RME scenario is "reasonable" because it is a product of factors, such as concentration and exposure frequency and duration, that are an appropriate mix of values that reflect averages and 95th percentile distributions (see the "*Risk Assessment Guidance for Superfund: Human Health Evaluation Manual*" [EPA 1989]).
[45] Integral et al. 2011
[46] Adolfson 1996
[47] Adolfson 1996
[48] EPA 2002a, Section 6, p. 39
[49] EPA 1989
[50] The nursing infant PRG for PCBs, and other conservative fish consumption scenarios discussed above, are below background, and EPA therefore defaulted to background.

The high degree of uncertainty associated with the calculations used to develop the nursing infant scenario would seem to preclude its use as a basis for a sediment cleanup decision. An example of the high degree of uncertainty is seen in the PCB concentration in breast milk that is projected by EPA's exposure assumptions. The BHHRA does not provide exposure point concentrations (EPCs) for breast milk. Instead, estimates of the mother's PCB chronic daily intake are multiplied by a factor of 25 (termed an infant risk adjustment factor [IRAF]), which is intended to represent the increase in intake for the nursing infant compared to the mother. The IRAF is based on Oregon Department of Environmental Quality (DEQ) guidance,[51] which calculates the IRAF based on estimated doses to mothers and infants and the resulting non-cancer risks to both groups. DEQ estimates doses to infants based on exposure calculations from EPA.[52] DEQ provides an example in which maternal consumption of 1 mg/kg PCB in fish at a rate of 17.5 g/day resulted in 2 mg/kg PCB in milk fat. Using those same dose calculations, a mother consuming fish with a fillet PCB concentration of 5 mg/kg at a rate of 175 g/day, as assumed in the BHHRA, would have PCB concentrations in milk fat of approximately 100 mg/kg.

For comparison, PCB concentrations in human milk compiled from the literature are shown in Table 3. The 100 mg/kg of PCBs in milk fat estimate implicitly derived in support of the EPA FS PRG and based on the exposure parameters in the BHHRA and the DEQ approach *is approximately 50 times higher than any of the mean concentrations reported worldwide*[53] and is more than 25 times higher than mean concentrations measured in studies of highly exposed populations.[54] Notably, it is also 150 times higher than the mean concentration reported in a Native American community consuming fish from the Saint Lawrence River[55], a site with much higher PCB sediment concentrations than Portland Harbor.

In addition to the apparent lack of consideration in the EPA FS of uncertainties and conservativeness of the nursing infant exposure scenario, using this exposure scenario is an unprecedented basis for a cleanup decision. A ROD search was conducted using the EPA ROD System,[56] which includes full-text RODs for Superfund sites through 2012. The database includes 260 RODs from all EPA Regions. It was queried using the search terms "human health," "nursing," "breast milk," and "infant." No RODs were identified where the nursing infant scenario was the basis for cleanup decisions. Moreover, the nursing infant scenario was not identified in any ROD summaries within Region 10.[57]

Table 3. Estimates of PCB Concentrations in Human Milk Compiled from the Literature

Site, Population	Breast Milk PCB (mg/kg lipid)	Citation	Citation Details
St. Lawrence River, Mohawk population	0.6	Fitzgerald et al. 1998	PCBs in human milk from 97 mothers from the Mohawk Tribe living along the St. Lawrence River where PCBs concentrations range up to 40,000 mg/kg in on-site soil and sludge and up to 5,700 parts per million (ppm) offshore in St. Lawrence River sediment.

[51] DEQ 2010
[52] EPA 1989
[53] ATSDR 2000, 2011
[54] Dewailly et al. 1989, Fangstrom et al. 2005
[55] Fitzgerald et al. 1998
[56] www.epa.gov/superfund/sites/rods/ (August of 2015)
[57] Outside of Region 10, two RODs from the same site (General Motors, Central Foundry Division) (EPA 1990, 1992) considered infant ingestion of breast milk as one of many pathways considered in the baseline risk assessment at a site with PCBs in groundwater, soil, sediments, and estimated in biota. However, the nursing infant pathway did not form the basis for remediation; instead, EPA identified risks associated with consumption of fish and wildlife (in the 1990 ROD) or wildlife (in the 1992 ROD) as having a much greater impact on site risks than any other pathway including the nursing scenarios. Another ROD from 1993 specifically mentions reaching out to recruit nursing mothers for biomonitoring during remediation activities to assess potential adverse health effects that may result from exposure to site metals (EPA 1993a). However, the nursing infant exposure pathway was not part of the risk assessment, nor was it in any way the basis for cleanup at this site. One ROD from 1998 considered nursing mothers one of many pathways in the toxicity assessment at a site with lead and PCBs in groundwater and soil (EPA 1998). However, the nursing infant pathway did not form the basis for remediation at the site; exposure to industrial workers was a much greater driver of remediation at the site.

Site, Population	Breast Milk PCB (mg/kg lipid)	Citation	Citation Details
Hudson Bay, Inuit population	3.6 (0.5 – 14.7)[(a)]	Dewailly et al. 1989	PCB concentrations in 24 Inuit women in northern Quebec in the late 1980s. Their dietary PCB exposure is expected to be high because their fish and marine mammal consumption rates are substantially higher than other populations.
Faroe Island, Residents	1.8 (0.69 – 4.6)	Fangstrom et al. 2005	Trends in PCB concentrations in breast milk in residents of the Faroe Islands, exposed to PCBs in their diet, which is primarily based on seafood and includes pilot whale meat and blubber and seabirds.
Worldwide compilation, ATSDR	(0.2 – 2.3)	ATSDR 2000, 2011	Mean PCB concentrations in human milk as 0.198 to 2.3 mg/kg lipid worldwide. LaKind et al.[58] overview of PCBs in human milk over time conclude that PCB concentrations in breast milk declined from ~1.8 mg/kg lipid in the late 1970s to less than 0.5 mg/kg lipid by 1991.
Portland Harbor, BHHRA (modeled)	100		

Note:
a) Numbers in parentheses indicate documented ranges.

1.2.1.3 Developing Achievable Human Health PRGs

EPA guidance states, "Any decision regarding the specific choice of a remedy for a contaminated sediment site should be based on a careful consideration of the advantages and limitations of available approaches and a balancing of trade-offs among alternatives."[59] Based on the information regarding human health and ecological risk presented above and understanding that PCBs via fish consumption represent the preponderance of risks to human receptors at the site, a more reasonable and achievable range of PRGs for PCBs can be calculated between 17 and 41 µg/kg. This range of PRGs is within the range of the RI calculated background sediment values for total PCBs (6 to 19 µg/kg with outliers removed, and 14 to 60 µg/kg for the full data set).[60] It is also consistent with the calculated equilibrium concentration range of 7 to 35 µg/kg PCBs.[61] This risk-based range of PCB PRGs is based on a non-cancer endpoint of 1 for the recreational CTE Scenario for child and adult fish consumption, respectively, with and without one anomalous carp result included as part of the multi-species diet.[62] The range of PCB PRGs for non-cancer endpoints falls within the range of PCBs calculated for a target cancer risk of 10^{-6} to 10^{-4} for the same consumption scenario (1.6 to 160 µg/kg).

Establishing a PCB PRG in the range indicated above will be protective of ecological receptors. In addition, it is important to recognize that site conditions are changing; hence, data used in the BHHRA do not reflect current risks at the site. Based on the tissue dataset used in the BHHRA, the baseline cancer risks associated with consuming smallmouth bass on a site-wide basis were calculated to be 4×10^{-4} and 1×10^{-4} for recreational RME and CTE scenarios, respectively. The non-cancer hazards were 30 and 10 for child recreational RME and CTE scenarios, respectively. Using the more recent 2012 tissue dataset, the cancer risks associated with RME and CTE scenarios for consuming smallmouth bass on a site-wide basis are 1×10^{-4} and 5×10^{-5}, respectively, and non-cancer hazards

[58] LaKind et al. 2001
[59] EPA 2005a
[60] EPA 2015b, Table 7.3-1
[61] LWG, 2014b. Sediment Equilibrium Estimates for the Revised Feasibility Study. Memorandum from the LWG to EPA Region 10. August 7, 2014.
[62] EPA's FS states "When fish consumption is evaluated on a harbor-wide basis, the estimated RME HI is 4,000 and 10,000 for breastfed infants of recreational and subsistence fishers, respectively." These elevated HI values are driven by one composite carp sample with a PCB concentration an order of magnitude higher than the remaining 63 samples.

were 10 and 5 for a child. It is expected that tissue concentrations and associated risk estimates have continued to decrease since 2012 and will continue to decrease during design and remedy implementation.

None of the alternatives results in acceptable cancer risks or non-cancer hazards for the subsistence scenario. However, as discussed above, a meals-per-month approach provides a better assessment of the gains achieved by each respective remedy. Based on EPA's projected SWACs for PCBs at time zero (immediately after active remedy completion), the numbers of meals per month that could be consumed and meet the target risk levels are as follows:

- For cancer risk of 10-4, between 3 to 17 meals per month could be consumed.
- For cancer risk of 10-6, less than 1 meal per month could be consumed for all alternatives, even at background.
- For non-cancer endpoint, an adult could consume between 1 and 4 meals per month, and a child could consume one meal per month for Alternative G
- For a nursing infant, the mother could consume less than 1 meal per month for all alternatives, even at background

Again, these are time-zero values; the net gain of meals per month for all alternatives is essentially the same when long-term monitored natural recovery (MNR) is considered (Figure 1). The meals-per-month approach can also be an important and informative tool in communicating the effectiveness of the various cleanup alternatives to the public. This approach provides a perspective on what types of risk reduction are possible for any given alternative.

EPA should also apply PRGs consistent with the exposure areas defined in the BHHRA. This is particularly relevant to carcinogenic PAH (cPAH) PRGs. EPA and the LWG agree that there is no significant relationship between fish tissue and sediment cPAH concentrations and, therefore, a reliable fish consumption PRG cannot be calculated and is not valid. EPA's proposed cPAH PRG is based on the clam consumption scenario. To be consistent with the BHHRA, the cPAH PRG based on shellfish consumption should be applied only in nearshore areas where shellfish harvesting could potentially occur. Because no human health risk relationship has been established between cPAHs and humans except in nearshore areas, SMAs for cPAHs should not be delineated in the navigation channel.[63]

The BHHRA also only shows risk for DDE (not total DDx) at a 10^{-6} level for fish consumption for large range fish. When EPA's risk level for PCBs is used for ingestion of smallmouth bass, the BHHRA shows that no risks for DDx exist at the site either on a river-mile or site-wide basis.

1.2.2 Baseline Ecological Risk Assessment

By focusing on worst-case scenarios in the BERA[64] and, in the case of benthic risk, by defaulting to screening level values outside the BERA, EPA's FS did not follow the NCP and EPA guidance in estimating potential exposures to benthic invertebrate communities and populations of fish and wildlife that feed within Portland Harbor. We reiterate the many similar concerns with EPA's reliance on conservative assumptions in the BERA as with BHHRA (e.g., reliance on an outlier carp sample point) and focus on the two technical deficiencies in the development of ecological PRGs.

[63] EPA's FS (EPA 2015b) also relies on Total PAH concentrations as a measure of toxicity and risk. TPAH concentration is not a reliable indicator of toxicity/risk requiring active remediation at Portland Harbor. Carcinogenic PAHs (cPAHs) are the dominant risk driver among PAHs in Portland Harbor sediments. An elevated TPAH concentration could be a result of non-carcinogenic PAHs that present little risk at the site. A proper RAL must be derived from the specific compounds that drive risk, not from a broad spectrum of compounds with risk factors that differ by orders of magnitude.

[64] Windward 2013

1.2.2.1 Generic vs. Site-specific Sediment Quality Values

In 2010, the LWG and EPA Region 10 developed the comprehensive benthic risk areas (CBRA) approach to identify areas of the Site that posed potentially unacceptable risks to benthic organisms. EPA directed the LWG to use the CBRA approach in the LWG's 2012 Draft FS. Consistent with that directive, the final BERA and 2012 Draft FS incorporated the derivation of site-specific sediment quality values (SQVs) for predicting potential risks to benthic invertebrates.[65]

Without explanation, EPA's FS reverted to using generic SQVs as the PRGs for the protection of benthic invertebrate communities. For example, the sediment PRGs for RAO 5 for DDx and PAHs are based on probable effect concentrations (PECs)[66] rather than site-specific SQVs. This is contrary to both guidance and precedents at other sediment cleanup sites.

The EPA FS disregards the CBRA approach and offers no technical basis for selecting less-reliable generic SQVs over more reliable, site-specific SQVs as PRGs for protection of ecological receptors from direct contact with sediment. In doing so, EPA's FS disregards EPA policy and guidance and the intent of the authors who developed the generic SQVs. EPA's ecological risk assessment guidance states that "[s]creening ecotoxicity values are derived to avoid underestimating risk. Requiring a cleanup based solely on those values would not be technically defensible."[67]

1.2.2.2 Individual vs. Population-level Risk Estimates

In its summary of the BERA, EPA's FS presents maximum hazard quotients (HQs) for wildlife receptors that were calculated using maximum concentrations as EPCs. Using maximum HQs is equivalent to using the maximum EPC to represent site-wide conditions—in either case, the level of risk present throughout the Site is greatly overestimated.

The EPA FS also relies on EPCs based on maximum prey tissue concentrations applied over the foraging range of individual organisms resulting in maximum potential risks to individual organisms rather than population-level risks. This is not only counter to the objective of the BERA (which identifies wildlife populations as ecological receptors),[68] but it is also counter to EPA's ecological risk assessment guidance, which stipulates that "assessment endpoints are any adverse effect on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments."[69]

The EPA FS does not consider site-specific data related to population-level risks to mink from PCBs when establishing the PRG for RAO 6 (prey ingestion by wildlife). The PRG does not take into account the site-specific, peer-reviewed analysis of potential population-level risks to mink that forage within Portland Harbor.[70] That analysis indicates that a protective sediment PRG for total PCBs could range from 79 to 640 µg/kg, which exceeds the EPA PRG by factors ranging from 2 to 10.

1.2.2.3 Developing Achievable Ecological PRGs

The primary use of the BERA in the EPA FS is to support the derivation of ecological PRGs, which are compared with time-zero estimated post-remediation sediment concentrations in the long- and short-term effectiveness

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[65] Attachment 6 of the BERA documents the development of SQVs using the floating percentile method (FPM) and logistic regression model (LRM).
[66] MacDonald et al. 2000
[67] EPA 1997, p. 2-5 p. 2-5 p. 2-5. The authors who developed the generic SQVs stipulate that site-specific, concentration/response relationships are preferable for deriving PRGs (Long et al. 2006). According to EPA's sediment remediation guidance (EPA 2005a), remedial goals should be based on site-specific data when available. Further, use of site-specific information is one of EPA's 11 risk management principles for contaminated sediment sites (EPA 2002b).
[68] Section 3.2
[69] EPA 1997, p. 1-6, emphasis added
[70] Luxon et al. 2014

evaluations.[71] The following modifications would result in more reasonable ecological PRGs that are more representative of potential risks in Portland Harbor:

- **Use the site-specific CBRA approach approved by EPA to establish benthic risk areas, and do not use generic SQVs to evaluate long-term effectiveness with respect to RAO 5.**[72] As described in Section 3.1.2.1 of the EPA FS, the ecological PRGs for the protection of benthic invertebrates are based on generic SQVs, ignoring the more reliable site-specific SQVs derived and included in the BERA. These are not appropriate values for assessing RAO 5. The site-specific SQVs developed based on the analysis of toxicity tests conducted with sediment from Portland Harbor should be used to evaluate RAO 5. Specifically, EPA should use the combined toxicity thresholds consistent with the BERA benthic risk evaluation. Using the CBRA approach, benthic risk areas are estimated to cover between 4 and 8% of the total surface area of sediment within the site.

- **Use exposure units that are appropriate for evaluating population-level risks rather than individual-level risks.** Risks to many wildlife receptors were assessed for 1-mile increments of the Willamette River using maximum reported concentrations of COCs due to data limitations. A more appropriate approach is one that integrates exposure over the entire site in order to better represent exposures to wildlife *populations* foraging within Portland Harbor, rather than individual organisms. This is particularly true for mink, for which a site-specific analysis was conducted to estimate a protective sediment concentration in Portland Harbor for local mink populations.[73]

- **Apply representative EPC for total PCBs for wildlife receptors.** EPCs should exclude the outlier data point that skews the whole-body fish concentration values.[74] With this adjustment, the EPC for PCBs in carp would decrease by an order of magnitude to a value that is more representative of actual tissue concentrations in Portland Harbor. This single outlier value inflates the exposure estimates for mink, river otter, osprey, and bald eagle. A more representative EPC should be selected from the whole-body carp dataset in order to derive a more reasonable PRG.

1.2.3 Residual Risk Assessment

EPA's residual risk assessment provides limited information on methodology but contains multiple inconsistencies with the BLRAs, including:[75]

- Risk estimates were based on time-zero SWACs calculated on spatial scales that are often inconsistent with the BHHRA and BERA exposure scales.

- Human health risks for the no action alternative are generally substantially higher than the baseline risks in the BHHRA (e.g., the highest non-cancer risk for a breastfeeding infant in the BHHRA was an HQ of 10,000, while the residual risk assessment indicates the highest HQ for this same scenario for the no action alternative is 210,000). These risk estimates should be consistent across the two evaluations because they reflect the same surface sediment concentrations. This indicates that EPA's residual risk evaluation is even more conservative than the PRGs themselves, which, as discussed above, are already too conservative.

- EPA's estimates of residual benthic risks use only a few of the CBRA lines of evidence and are generally inconsistent with the BERA risk assessment methods

- Residual risks are presented only for RME scenarios, and for the reasons discussed above, the CTE scenarios are likely to be more realistic.

[71] EPA 2015b, Section 4
[72] RAO 5: Reduce risks to ecological receptors from ingestion of or direct contact with COCs in sediment to acceptable exposure levels
[73] Luxon et al. 2014
[74] See fn 62 supra
[75] LWG 2015c, 2015d

1.3 Focus on Risk Reduction, Rather than Mass Removal

To ensure that remedial alternatives are sufficiently protective of human health and the environment, remedial alternatives should be developed to achieve significant risk reductions. The NCP states, "The results of the baseline risk assessment will help establish acceptable exposure levels for use in developing remedial alternatives,"[76] indicating that the viable remedial alternatives should result in reducing risk to acceptable levels. Numerous EPA guidance documents[77] further emphasize that key objectives of the risk assessment process at Superfund sites include identifying cleanup levels that are protective of human health and ecological resources at risk and developing remedial alternatives capable of reducing unacceptable risks. With respect to contaminated sediment sites, EPA has specifically addressed the role of risk reduction in *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites*,[78] stating that "there is wide-spread agreement that risk assessment should play a critical role in evaluating options for sediment remediation,"[79] and project managers must "ensure that sediment cleanup levels are clearly tied to risk management goals."[80]

EPA regulatory or guidance materials do not emphasize the need to evaluate alternatives for levels of mass removal via dredging or excavation in developing or evaluating remedial alternatives. Furthermore, guidance documents published by the National Research Council (NRC) discourage the use of mass removal targets as proxies for risk reduction goals. In particular, the NRC asserts that "[r]emedies should be designed to meet long-term risk-reduction goals (as opposed to metrics not strictly related to risk, such as mass-removal targets)"[81] and that "the reduction of [contaminant] mass in sediments is not necessarily equivalent to reduction in exposure or risk."[82] While mass removal often plays a crucial role at contaminated sediment sites, it should not be presumed to be more effective at achieving risk reduction goals than remedial alternatives employing containment, MNR, or in situ treatment.

The EPA FS emphasizes mass removal, de facto, through the subjective and prescriptive technology assignment scoring approach, which results in extensive dredging that is identical in all alternatives. In effect, the EPA FS presents alternatives that are solely defined and differentiated by the size of the SMAs. As a result, the FS evaluation of remedy alternatives against the NCP criteria is an evaluation of *how much to dredge* or *how much to cap* to achieve remedy-specific RAL, not whether to dredge or cap within an SMA as defined by the RAL. The relative effectiveness of dredging, capping, MNR, thin-cover placement, use of activated carbon, or other remedies is never evaluated and contrasted for any specific area.

Similarly, EPA's FS defines areas for active remediation without demonstrating any clear relationship between sediment cleanup in those areas and risk reduction. For example, the unacceptable human health risks associated with the consumption of fish from Portland Harbor that were estimated in the BHHRA were primarily driven by PCBs and not cPAHs.[83] As such, the PRGs derived for cPAHs by EPA are based on direct contact exposures (e.g., beaches) and consumption of clams rather than consumption of fish. However, EPA delineated SMAs based on exceedances of PAH RALs throughout the entire waterway, including within the navigational channel where direct contact and clam consumption pathways do not apply. All of EPA's alternatives include only dredging in the navigation channel and other navigation areas. The SMA delineation should take into account the exposure pathways demonstrating unacceptable risks for the COCs rather than looking solely at exceedances of RALs.[84]

Dredging is not without its own risks. Remedies that incorporate large dredging volumes are less protective on a short- and long-term basis due to the longer period of exposure of the fish to inevitable contaminant releases and resuspension, which occur during dredging despite utilization of "Best Management Practices" (BMPs). These releases directly translate into increased fish tissue concentrations of PCBs and other COCs, which persist for many years after the dredging has been completed. This exposure is significantly magnified as the amount and duration of

[76] 40 CFR 300.430(d)(4)
[77] EPA 1997, 1999, 2005
[78] EPA 2002b
[79] EPA 2002b, p. 5
[80] EPA 2002b
[81] NRC 2007 p. 8
[82] NRC 2001, p. 11
[83] This issue is applicable to other COCs as well, including dioxin/furan.
[84] Similarly, the DDX and dioxin/furan RALs are not well aligned with the BLRAs.

dredging increases, as is the case with several of the EPA FS Alternatives. An example of the adverse long-term impact of dredging releases is the Commencement Bay (Washington) dredging history. Before two significant dredging projects (~400,000 cy in 1994-5 in the Blair and Sitcum Waterway and ~1,100,000 cy in 2003-4 in the Hylebos, Middle, and Thea Foss Waterways), the PCBs levels in 1991 fish tissue were about 48 µg/kg. These levels spiked to 140 µg/kg in 1994-5 and 205 µg/kg in 2003-4 as a result of these two large dredging projects. Twenty years later, in 2011, the fish tissue levels are still around 100 µg/kg, which is well above the 1991 pre-dredging levels. This amounts to a significant long-term impact to the fish and the people who eat them that would reduce the effectiveness and protectiveness of those remedies.

Evaluation of the comparative net risk reduction potential of the comprehensive alternatives should be conducted consistent with the BLRAs, including the risks introduced by implementing the alternatives and the risk reduction achieved by each alternative. The general emphasis in the EPA FS on removing contaminants through dredging is not consistent with this principle, and neither is the technology assignment scoring process, which gives higher scores to dredging versus containment technologies.

1.4 Consider Measures to Reduce Interim and Short-term Exposures

As discussed in the LWG's 2012 Draft FS and above, fish consumption risks are likely to increase during remedy implementation as construction activities resuspend contaminants in bedded sediments. EPA generally recognizes this in Section 4 of its FS. The emphasis on dredge remedies in the EPA FS would exacerbate short-term exposure through fish consumption. The EPA should work with other Portland Harbor stakeholders to identify functional opportunities for minimization of interim and short-term risks during the cleanup. For example, EPA could work with landowners on whether strategic locations of improvements to access to the river could encourage recreational or subsistence fishing in areas of lower sediment contamination. The community and potentially responsible parties could assist in the creation of innovative and scientifically grounded programs that provide interim measures to help mitigate risk from fish consumption and enhance site-specific data to better understand how to communicate effectively about risk.

1.5 Acknowledge that Sediment Cleanup Will Not Remove Fish Advisories

Although one of the RAOs for Portland Harbor is to reduce human health risks associated with consuming fish, remedial actions in Portland Harbor will not address all fish consumption advisories. For example, remediation will not address the river-wide mercury fish consumption advisory. The dominant source of mercury to the Willamette River is runoff of native soils, mostly from agricultural lands, throughout the watershed.[85] Therefore, although active remediation of sediment and MNR in Portland Harbor is expected to reduce concentrations of PCBs and other organic COCs in resident fish, unlimited consumption of fish from the Willamette River is not likely to be possible for the foreseeable future.

2. <u>Reduce the Uncertainty about Natural Recovery</u>

The RI empirical data show natural recovery of sediments is occurring at the site in many places, and natural recovery has been further documented by the LWG's 2012 fish data and the 2014 sediment PCB data. The EPA FS is missing key components required to evaluate the effectiveness of MNR as a technology in the FS, including 1) an adequate conceptual site model (CSM), and 2) appropriate evaluation of multiple lines of empirical evidence. We request that EPA consider these deficiencies and build in an approach to fill these gaps in the development of the proposed plan.

2.1 Site-specific and Robust CSM

To formulate and implement effective remedial alternatives at Superfund sites, site-specific conditions must be well characterized and incorporated into an accurate CSM. NRC guidance stresses the importance of conducting risk management decisions "on a site-specific basis…incorporat[ing] all available scientific information" because "[w]ithout a valid conceptual model of the site, it is not possible to define how a management option can successfully meet the risk-reduction goals and objectives."[86] At contaminated sediment sites in particular, "the

[85] Hope 2005
[86] NRC 2001

development of an accurate conceptual site model, which identifies contaminant sources, transport mechanisms, exposure pathways, and receptors at various levels of the food chain" is "especially important...because the interrelationship of soil, surface and groundwater, sediment, and ecological and human receptors is often complex."[87] EPA's *Technical Resource Document on Monitored Natural Recovery* explains that an evaluation of the feasibility of MNR (and presumably other proposed remedial alternatives) "is best achieved through the development of a CSM that adequately captures the physical, chemical, and biological processes that control contaminant fate, transport, and bioavailability."[88]

Neither the RI nor the EPA FS contains a coherent or complete CSM that identifies site-specific conditions in adequate detail to support development and evaluation of alternatives.[89] For example, while EPA's FS contains an overlay of bathymetry data from 2002, 2003, and 2009, it largely omits substantial integrated discussion of surface water hydrology, sediment characteristics (e.g., grain size), sediment transport, bedload movement, upstream sediment loads, and sedimentation processes. Also, other important elements of an integrated CSM are omitted, including site uses, biological habitats and potential restoration sites, biological receptors in sediment and surface water, how humans access and use the river for navigation and recreation, chemical distributions in subsurface sediments, biota tissue, transition zone water, and details of site sources. These are critical components of a robust, site-specific CSM that are entirely absent or only sporadically mentioned in EPA FS.[90] EPA's FS contains one sentence presenting the FS CSM in Section 1, which merely cites a one-page cartoon that sketches some of the site receptors and processes.

EPA's FS devotes one paragraph and one figure to the LWG's 2012 smallmouth bass data collection, which confirmed a statistically significant decreasing trend in smallmouth bass tissue concentrations based on fish collected in 2002, 2007, and 2012. Multiple lines of evidence, including time series bathymetry data, the fine-grained nature of the majority of site surface sediments, surface to subsurface sediment contaminant concentration ratios, and detailed sediment transport modelling all indicate the majority of the site is depositional. An appropriate analysis of the bathymetry empirical data indicates that 63% of the site is reliably depositional (EPA's analysis of these same data indicate the site is 47% depositional) and that an additional 25% of the site is stable (i.e., no substantial bed elevation change). Thus, approximately 88% of the site is stable or depositional.

2.2 Quantitatively Evaluate the Effectiveness of MNR

EPA and the LWG agree that MNR will be an important element of the Portland Harbor remedy. However, because EPA declined to use either the QEAFate model developed by the LWG or its own SEDCAM model to predict the rate of natural recovery in the EPA FS, and because all of EPA's alternatives rely to some extent on MNR, it is unclear how EPA concluded that FS alternatives B through G met the threshold criterion of protectiveness.[91] In fact, EPA's time-zero SWAC analysis indicates that none of the alternatives achieves all of the sediment RAOs and related sediment PRGs.

Like the threshold criterion evaluation, long-term effectiveness was evaluated qualitatively in the EPA FS. Post-remediation EPCs were based on estimates of contaminant concentrations in sediment at the completion of construction. These concentrations were determined by assuming the post remediation concentration was 2.5% of the baseline (pre-FS) concentration in remediated areas and baseline concentrations for unremediated areas.[92] So-called "residual risks" were calculated using these estimated post-remediation EPCs, and the extent of the comparison among remedies was limited to the following qualitative statements: "[t]he resulting risks and hazards following the completion of construction are greatest under Alternative B and least under Alternative G" and "[t]he

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[87] EPA 2005a, p. ii
[88] EPA 2014a, Section 1.3.2, p. 6
[89] We do not understand the reference in Section 4 of the EPA FS to the "Site CSM," because Section 1 provides only a simplified visual summary of EPA's contaminant fate and transport hypothesis and two figures depicting exposure scenarios used in the baseline risk assessments.
[90] EPA's decision to include riverbanks in the FS evaluations highlights one of the major problems associated with the lack of a CSM. Riverbanks were not evaluated in the Portland Harbor RI, and the EPA FS includes no data, risk assessment or other means by which to evaluate the adequacy (or need for) remediation of any riverbank location. DEQ has worked aggressively to control sources of potential contamination to the river, including erosion of riverbank soils, and DEQ should continue this work, including integrating source control actions with planned sediment cleanup on an area-specific basis as appropriate.
[91] See Table 4.3-1
[92] EPA FS, Appendix H, p.3

time needed for MNR to achieve the RAOs is greatest for Alternative B and least for Alternative G."[93] This is inadequate for comparing alternatives, particularly when making remedy decisions for a site of the magnitude and scale of Portland Harbor. The evaluation of time to achieve RAOs is not supported by a quantitative analysis of the recovery process, and EPA's statements regarding time to achieve RAOs and PRGs cannot be analyzed by the NRRB, potentially responsible parties, or the public.

EPA's entirely qualitative evaluation of the remedial alternative's long-term effectiveness makes the FS incomplete and inconsistent with guidance expectations on the use of quantitative long-term projections, i.e., models.[94] Although models are never perfect, the QEAFATE model is the best available tool for making such long-term projections and can do so within an acceptable range of accuracy for an FS analysis. The existing model projections are entirely consistent with the findings of 2014 PCB surface sediment data, both of which show a similar decline in sediment PCB concentrations over the last approximately 10 years.[95] The LWG would like to meet with EPA and its modelling experts to better understand their concerns with the QEAFate model and to discuss potential refinements to or additional tests of the model that might enhance EPA's confidence in the model's ability to predict natural recovery and the long-term effectiveness of the alternatives. Pre-construction baseline data and other information collected during remedial design will further reduce uncertainty and help refine the model.

3. <u>Improve the Accuracy and Transparency of the Assumptions behind the Remedial Alternatives and Explain How Additional Risk Reduction Justifies Higher Cost Actions</u>

The EPA FS relies on qualitative analyses, conservative or unrealistic assumptions, and incomplete or missing information, leading to the development of unrealistic remedies that are not readily implementable and are not appropriately linked to risk.

3.1 Remove "Principal Threat Waste" Designation from Materials that Can Be Reliably Contained

EPA guidance states that wastes will not always be "readily classifiable as either a principal or low level threat waste, and thus no general expectations on how to best manage these source materials of moderate toxicity and mobility will necessarily apply."[96] The concept of PTW was developed in order to streamline the remedy selection process rather than be a "mandatory waste classification requirement."[97] We understand this is an area in which CSTAG members have considerable expertise, and we look forward to reviewing their recommendations.

The delineation of PTW in the EPA FS is inconsistent with the NCP and EPA guidance and is unprecedented in contaminated sediment sites throughout all EPA regions and is unnecessary for selecting a remedial alternative that is protective of human health and ecological receptors. Important engineering factors associated with PTW (e.g., treatment alternatives and feasibility) are insufficiently considered in the EPA FS.

EPA defines areas as PTW without evaluating whether contaminants are or can be reliably contained. "Principal threats are characterized as waste that cannot be reliably controlled in place, such as liquids, highly mobile materials (e.g., solvents), and high concentrations of toxic compounds (e.g., several orders of magnitude above levels that allow for unrestricted use and unlimited exposure)."[98] Thus, only the areas that EPA designates as "not reliably contained" have the potential to actually be defined as PTW. Such an evaluation has not been performed to define PTW within the site.

EPA's "not reliably contained" analysis resulting in the use of a so-called "super cap" is technically incorrect. EPA delineates the need for the "super cap" based on generalized site-wide groundwater seepage potential rather than localized knowledge and calculations available in the RI. Further, groundwater control systems exist at both Gasco and Arkema sites. At the Gasco site, the groundwater source control system has been shown to cause negative seepage (i.e., movement of river water down into the sediment bed) over broad areas of the offshore sediments, but

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[93] EPA FS, Section 4.3.3
[94] EPA 2005a
[95] The LWG can provide additional information comparing model results to the 2014 PCB sediment data.
[96] EPA 1991, p. 2
[97] EPA 1991, p. 2
[98] NCP Preamble, 55 FR 8666 at 8703 (March 8, 1990)

EPA's super cap analysis assumes that positive groundwater seepage out into the river is still occurring. Using appropriate seepage parameters where groundwater source control systems exist would result in no identification of "not reliably contained" material at the Gasco site. A similar analysis is appropriate for sediments offshore of the Arkema site, which has installed a slurry wall and a groundwater extraction and treatment system designed to prevent migration from the uplands to the river. EPA should consider the specifics of that groundwater control system, as well as other areas with significantly lower than average groundwater gradients.

3.1.1 Evaluate Toxicity Consistently with PTW Guidance and the BHHRA

EPA's *A Guide to Principal Threat and Low Level Threat Wastes*[99] defines PTW as "source material" "that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or act as a source for direct exposure." Source materials "include liquids and other highly mobile materials (e.g., solvents) or materials having high concentrations of toxic compounds. No 'threshold level' of toxicity/risk has been established to equate to 'principal threat.' However, where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, generally treatment alternatives should be evaluated."[100]

Section 3 of the EPA FS delineates PTW based solely on the following two characteristics: 1) areas where sediment concentrations exceed human health cancer risks of 10^{-3}, and 2) areas in which nonaqueous phase liquids (NAPLs) are present in surface sediment. To address the first point, the EPA FS identifies "highly toxic" sediment by multiplying 10^{-6} cancer risk PRGs by 1,000 to identify sediment thresholds that correspond to 10^{-3} cancer risk. This approach is inconsistent with both EPA guidance and with the BHHRA.

Most importantly, EPA guidance[101] describes PTW as a source for "direct exposure." The fish consumption pathways are, by definition, indirect pathways from sediment through fish to people, and these pathways do not represent "direct" exposures from sediment contaminants as described in the guidance.

Even if it were appropriate to use indirect exposure to define PTW, if CTE scenarios (as discussed in Section 1.2.1.) were used in an evaluation of PTW for PCBs, the concentration threshold would be closer to 20,000 µg/kg, which is much higher than any concentrations detected at the site. Section 3.2.1 of the EPA FS designates PTW thresholds for dioxin/furan toxic equivalent (TEQ), total DDx, and PAHs even though risks for these COCs reported in the BHHRA do not exceed 10^{-3}. There is no basis for defining PTW based on dioxin/furan TEQ, total DDx, and PAHs, and the definition of PTW for these constituents should be removed from the PTW evaluation.

Finally, the point-by-point application of the EPA FS PTW thresholds is inconsistent with the spatial and temporal scales associated with the indirect exposure fish consumption pathway as described in the BHHRA. Exposures in the BHHRA are modeled over exposure units that represent individual areas where exposures are likely to occur (i.e., a specific beach or fishing area). For bioaccumulative constituents like PCBs, sediment concentrations within the exposure units are averaged to best represent that human exposures are averaged over time and space. The exposure units for the fish consumption pathway ranged from site-wide to individual EPA river miles, depending on the home range of the fish species. In its delineation of PTW, however, the EPA FS uses the "highly toxic PTW thresholds" as not-to-exceed sediment concentrations without regard to the spatial scale over which fish exposures actually occur. When applied to a fish consumption exposure scenario, a 10^{-3} level of risk would apply to area averages that combine relatively high and low sediment concentrations. Sediment concentrations averaged over reasonable fish exposure units (e.g., 1-mile increments) are less likely to ever exceed the EPA FS's overly conservative PTW thresholds.

The PTW threshold concentrations proposed in the EPA FS would be considered completely safe under established remedial and regulatory scenarios. For example, the EPA FS's PTW level for PCBs of 200 µg/kg is below EPA's Regional Screening Levels (RSL) for residential soil, which range from 230 to 3,900 µg/kg.[102] DEQ's risk-based

[99] EPA 1991, p. 1
[100] EPA 1991, pp. 1-2, emphasis added
[101] EPA 1991
[102] http://www2.epa.gov/risk/risk-based-screening-table-generic-tables

residential soil cleanup standard for PCBs is 200 μg/kg. The PTW approach of the EPA FS results in large relatively low-concentration areas of the site being identified as PTW. For example, large PTW areas exist outside much of the SMA footprint of the smaller alternatives (e.g., Alternatives B and C). In fact, PCB PTW level is equal to the Alternative D RAL, which could suggest an intrinsic bias against Alternatives B and C, both of which include unremediated sediment areas with PCB concentrations above the proposed PTW threshold.

The EPA FS is using extremely low dioxin/furan PRGs for PTW determinations that the LWG has previously commented are technically incorrect and not reflective of actual baseline risks.[103] Also, as noted above for PCBs, the dioxin and furan PTW levels in the EPA FS are extremely low compared to established regulatory programs. For example, the tetrachlorodibenzo-p-dioxin (TCDD) PTW level in the EPA FS is 10 nanograms per kilogram (ng/kg; or parts per trillion) in Table 3.2-1 of the EPA FS, while EPA's soil remedial goal for residential areas is 50 ng/kg.

3.1.2 Evaluate Stability and Mobility of Sediments When Determining PTW

The EPA FS simply equates PTW with a threshold carcinogenic risk value, regardless of and without clearly understanding the materials' stability or mobility. "The concept of principal threat waste and low level threat waste as developed by EPA in the NCP is to be applied on a site-specific basis when characterizing source material."[104] The EPA FS does not explain how PCB concentrations at 200 μg/kg act as "source material" in the river. It is inappropriate and insufficient to define "source material" solely by the level of risk associated with that material—doing so is inconsistent with the NCP and EPA guidance regarding PTW. Further, EPA uses inapplicable and inferential evidence to identify potentially highly mobile PTW (i.e., NAPL) in a manner that is inconsistent with the PTW guidance. The highly mobile aspect of the PTW definition should be applied for NAPL consistent with situations described in the guidance[105] such as "pools of NAPLs" submerged beneath groundwater or in fractured bedrock, "NAPLs floating on groundwater" or where physical processes are likely to mobilize "source materials." EPA's identification of any potential NAPL as PTW (e.g., solid tar materials at Gasco, inconclusive evidence from Arkema cores, and trace NAPL evidence such as "blebs and globules") is clearly inconsistent with the terms used in the guidance, such as "pools of NAPLs."[106]

The EPA FS provides no analysis of sediment mobility, nor is there any explanation of how material with sediment concentrations above the PTW thresholds identified in the EPA FS poses risks associated with contaminant mobility. In contrast, EPA explicitly warns against such an approach:

> Principal and low level threat waste should not necessarily be equated with the risks posed by site contaminants via various exposure pathways. Although the characterization of some material as principal or low level threats takes into account toxicity (and is thus related to degree of risk posed assuming exposure occurs) characterizing a waste as a principal threat does not mean that the waste poses the primary risk at the site.[107]

3.1.3 Maintain Consistency with PTW Approach at Other Sediment Sites

The LWG conducted a ROD search using the EPA ROD System.[108] Search terms used were "principal threat waste," "principal waste," and "PTW." Additionally, full-text RODs issued after 2012 were obtained by searching the EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database. Table 4 summarizes the search results, the outcome of which demonstrates that EPA's reliance upon a risk-based definition of PTW without considering mobility or the risk of direct exposure, as presented in Section 3 of the EPA FS, does not conform to EPA's approach to PTW at other Superfund sites.

[103] LWG 2014a, 2015a, 2015b
[104] EPA 1991
[105] EPA 1991
[106] EPA's 2009 Administrative Settlement Agreement and Order on Consent for the Gasco Sediment Site (the 2009 Gasco Order) includes specific protocols for management of identified "substantial product," including potentially mobile DNAPL.
[107] EPA 1991, p. 2
[108] www.epa.gov/superfund/sites/rods/, as of August 2015

Two additional recent high-profile sediment sites address PTW and are relevant to the application of the PTW concept in Portland Harbor: the Lower Passaic River and the Housatonic River (Rest of River). They are not included in Table 4 because RODs have not yet been issued for either site.

In the Proposed Plan for the Lower Passaic River, EPA states that “identification of principal and low level threats is made…to help streamline and focus the remedy selection process, not as a mandatory waste classification requirement.”[109] In EPA Region II’s response to the NRRB, EPA states that the “Region concluded that the principal threat/low level threat waste concept does not help streamline and focus the remedy selection process.”[110] Region II considers the highest concentration sediments in the river to be PTW, based on toxicity, but that it can be reliably contained without treatment.[111]

EPA indicated that PTW is present within the Housatonic River (Rest of River) because human health risks from fish consumption exceed 10^{-3}.[112] However, PTW was not delineated even though sediment PCB concentrations exceeded 500 mg/kg. In its response to the NRRB, EPA references EPA guidance[113] as a basis for not delineating PTW sediments for treatment.[114] EPA says that “although the NCP provides a preference for [PTW] treatment, treatment has frequently not been selected for contaminated sediment…Based on available technology, treatment is not considered practicable at most sediment sites…[and] in situ containment can also be effective for [PTW], where that approach represents the best balance of the NCP nine remedy selection criteria.”[115]

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[109] EPA 2014b, p. 2
[110] EPA 2014d
[111] EPA 2014d
[112] Weston 2011
[113] EPA 2005a
[114] EPA 2012
[115] EPA, p. 5

Table 4. Precedent for PCB PTW in RODs from Sediment Cleanup Sites

Site	Location	ROD Year	PTW Defined	PTW Present	PTW Levels	Maximum Reported Risk	PTW Applications
Lockheed West Seattle	Seattle, WA Region 10	2013	Yes	No	50 mg/kg	3×10^{-3}	Maximum surface sediment concentration observed was 3 mg/kg. No PTW delineated on-site.[116]
Sheboygan Harbor	Sheboygan, WI Region 5	2000	Yes	Yes	50 mg/kg	1×10^{-2}	Surface-sediment fish-consumption-based PRG is 0.5 mg/kg (10^{-4} risk). Source material presenting levels of risk "several orders of magnitude" greater than the PRG are considered PTW. PTW threshold corresponds to 10^{-2} risk (50 mg/kg). Only areas subject to mobility are defined as PTW.[117]
Fox River OU1/OU2	Lower Fox River & Green Bay, WI Region 5	2002	Yes	Yes	N/A	7.2×10^{-4}	Source material resulting in risk > 10^{-3} defined as PTW. Though the ROD says such waste is present, the maximum risk reported in the ROD is 7.2 X 10^{-4}. It is impracticable to delineate PTW specifically, but the remedy is expected to remove all PTW.[118]
Lower Duwamish Waterway	Seattle and Tukwila, WA Region 10	2014	Yes	No	N/A	3×10^{-3}	Direct contact risk used to define PTW. Whereas seafood consumption risks were estimated in excess of 10^{-3}, direct contact risks were below 10^{-3}. No PTW was delineated on-site. The maximum surface PCB concentration was 890 mg/kg.[119]
Hudson River PCBs (OU2)	Hudson River, NY Region 2	2002	Yes	Yes	Section 1: 3 g/m^2 Tri+PCBs; Section 2: 10 g/m^2 Tri+PCBs	1×10^{-3}	The ROD-defined PTW, as represented by mass per unit area measurements, are 3 g/m^2 Tri+ PCBs in River Section 1 and 10 g/m^2 Tri+ PCBs in River Section 2. No indication that PTW was used to delineate the remedy during remedial design and implementation.[120]
Grasse River	Massena, NY Region 2	2013	No	Yes	N/A	2×10^{-2}	Most highly contaminated sediment classified as PTW (unquantified) due to its role as a PCB source to surface water and fish. PTW can be contained reliably under an armored cap, and PTW treatment is neither practicable nor cost effective.[121]

[116] EPA 2013a
[117] EPA 2000b
[118] EPA 2002d
[119] EPA 2014c
[120] EPA 2002c
[121] EPA 2013b

The LWG's concerns with EPA's technology assignment approach are best illustrated by comparing the actual sediment remedy constructed at the McCormick and Baxter Superfund site (a separate NPL site in Portland Harbor) to the remedy that would have been selected for this area using EPA's FS technology assignment process. The actual cost of the cap construction at the McCormick and Baxter site was $12 million,[122] and has been shown to be highly effective through several years of post-construction monitoring. The LWG applied EPA's FS technology assignment process as closely as possible using the information presented in Section 3, which resulted in additional cleanup actions to address PTW, ex situ treatment, and disposal that were not part of the actual capping remedy. We determined that the likely construction costs for EPA's FS approach as applied to the McCormick and Baxter site would be approximately $370 million (with no net present value calculation and excluding any contingency allowance, operations and maintenance costs, and long-term monitoring costs).

3.2 Do Not Require Treatment of PTW when No Additional Risk Reduction Is Achieved

Although the EPA FS asserts that treatment of PTW is only a "preference," the document's decision trees indicate that PTW is almost always subject to treatment including reactive armored caps, reactive residual cover layers after PTW is removed (apparently, regardless of post-dredge residual concentrations), in situ treatment, or ex situ treatment after removal and before disposal.[123]

The EPA FS's PTW approach contributes substantial ex situ and in situ treatment components to both removal and in-place technologies for all alternatives both inside and outside of SMAs, as well as extensive sheet piles (and associated costs) for removal in some areas. For example, Alternative B involves ex situ treatment of 240,840 to 321,120 cubic yards (cy) of sediment, which is about 39% of the total volume removed under this alternative. PTW guidance does not support the need for treatment for all the materials falling within the EPA FS' wide definition of PTW for this site.

From a purely engineering perspective, it is unnecessary to conduct ex situ treatment of EPA FS-identified PTW before disposing of this material in a permitted landfill. The landfill acceptability criteria the EPA FS discusses in Section 3 indicate that some types of Draft-FS-designated PTW would be reliably contained at the landfill without need for prior ex situ treatment. This issue should be evaluated on an SMA-specific basis as part of remediation waste profiling.[124]

3.3 Assign and Compare Technologies on a Localized Scale

The use of a prescriptive set of technology evaluation and scoring criteria to determine the technologies to be applied in each area of the site rigidly assigns technologies to respective area in the river, without appropriately comparing technology options.[125] By assigning one technology to the same sediment areas in the technology screening step,[126] the technology assignment prevents meaningful comparison of technology performance and limits the evaluation of multiple technologies in Section 4 of the EPA FS.[127]

This approach is inconsistent with the NCP, which requires the comparison of remedy alternative based on the nine NCP criteria. In effect, the EPA FS presented alternatives defined and differentiated by the size of the SMAs. In other words, the EPA FS evaluates how much to dredge or cap to achieve remedy-specific RAL, not whether to dredge or cap within an SMA as defined by the RAL. Thus, the EPA FS does not adequately compare the relative

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[122] EPA 2005b

[123] Containment was used at the Grasse River Superfund Site where treatment was not prescribed for PTW because in 2013 "[US]EPA does not believe that treatment of the principal threat wastes is practicable or cost effective given the widespread nature of the sediment contamination and the high volume of sediment that would need to be addressed" (EPA 2013b, p. 49).

[124] For example, the 2009 Gasco Order contains a highly detailed protocol for managing dredged materials prior to disposal. The terms of the 2009 Gasco Order should be incorporated into EPA's FS, and similar remediation waste management criteria could be developed at other SMAs during remedial design.

[125] EPA (1988) indicates the FS should "assemble the selected representative technologies into alternatives representing a range of treatment and containment combinations, as appropriate" (p. 4-3). EPA (2005a) indicates, "The project manager should take into account the size, characteristics, and complexity of the site. However, due to the limited number of approaches that may be available for contaminated sediment, generally project managers should evaluate each approach carefully, including the three major approaches (MNR, in-situ capping, and removal through dredging or excavation) at every sediment site at which they might be appropriate" (p. 3-2).

[126] EPA 2015b, Section 3

[127] EPA 2015b

effectiveness of dredging, capping, MNR, thin-cover placement, use of activated carbon, or other remedies for any specific area. EPA's FS simply compares one set of RALs against another—just larger areas of active remediation versus smaller areas.

Direct detailed comparisons of one technology to another would also allow the community to provide meaningful comment on the tradeoffs between more aggressive options that might result in shorter restoration timeframes and less aggressive options that might have fewer quality of life impacts.

The LWG reviewed FS alternatives developed for five other large sediment sites (Duwamish, Fox, Hudson, Lower Passaic Focused FS, and Housatonic Rest of the River), and in every case, those studies included alternatives that compared the application of one technology (e.g., dredging) to another (e.g., capping) as applied to the same areas of sediments.

EPA's approach also ignores fundamental facts about the localized nature of dredging versus capping in general. As the RALs decrease, the depth of contamination increases, the dredge volumes increase, and the potential for dredging impacts on stable slopes and nearby structure stability increases. Also, as RALs decrease, the ability of dredging alone to effectively meet the RALs decreases. And the potential effectiveness of a post-dredging cap or cover to provide chemical isolation of remaining contamination increases. These general facts support the concept that the technology assignments could change at a given location across a range of potential RALs and alternatives. In contrast, EPA's scoring approach does not even recognize depth of contamination as an implementability factor related to selection of dredging.

EPA should evaluate technologies on a more localized and detailed scale so that it can demonstrate that its remedy selection will cost effectively optimize risk reduction. If it does not do so in the FS, EPA must allow flexibility to refine technologies and engineering processes during remedial design rather than rigidly apply a prescriptive technology-assignment matrix.[128] This approach would allow flexibility in technology selection on an SMA-specific basis so long as the performance goals (risk reduction or SWACs) are met.

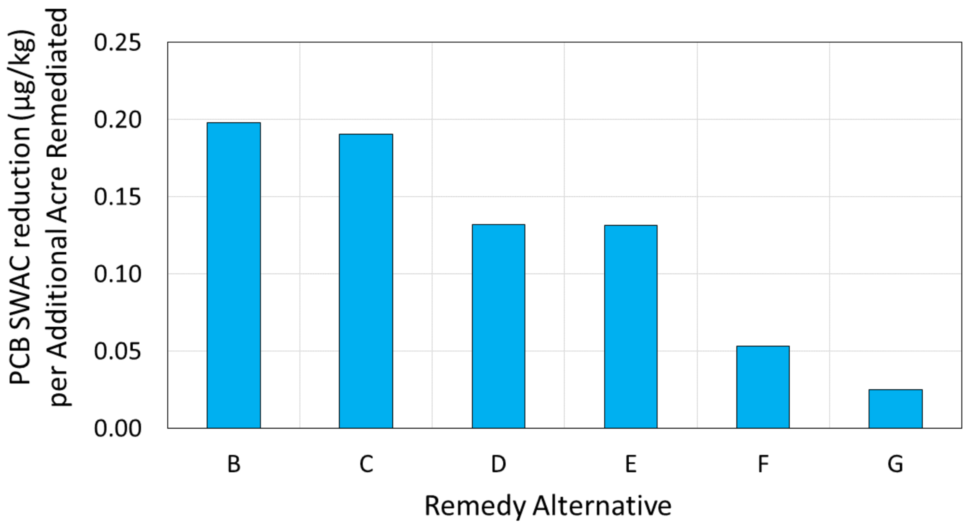
3.4 Compare Long-term Effectiveness of the Alternatives Quantitatively

For reasons that remain unclear to the LWG, only Alternative C was screened out during the qualitative screening discussion in the EPA FS. EPA's stated rationale was that between Alternatives B and C there is a small incremental increase in quantities of dredge and borrow materials and a small incremental decrease in the time-zero SWACs estimated for immediately after construction. A better common-sense measure of effectiveness would be to critically examine alternatives that involve a large incremental increase in active remediation acres while obtaining a relatively small decrease in the SWACs achieved.

Figure 2 uses such an approach and compares the incremental change in active remediation acres and the additional PCB SWAC reduction achieved by moving to each successively larger alternative. The largest PCB SWAC reductions are associated with remedy Alternatives B and C; both achieve comparable SWAC reductions in proportion to the areas remediated. Because the post-remedy SWAC for Alternative B is estimated to be approximately 49 µg/kg after remediating 212 acres, the PCB SWAC reduction per acre remediated is (87–49 µg/kg)/212 acres, or 0.20 µg/kg-ac. The remediation efficiency drops off for Alternatives D and E; i.e., the remediation efficiency for Alternatives D and E is approximately 30% less than for Alternatives B and C. Figure 2 shows that minimal PCB SWAC reduction realized for each additional acre remediated under Alternatives F and G; Alternatives F and G are only 13% to 28% as efficient Alternatives B and C. Based on this analysis, EPA should screen out Alternatives F and G and should retain Alternative C for further evaluation.

[128] For example, the 2012 draft EE/CA for the Gasco Sediments Site evaluates a range of technologies using comprehensive site-specific data at a high degree of detail to develop remedial alternatives for that location. These detailed SMA-specific alternatives should serve as the basis for remedy selection at the Gasco site, not the technology assignments based on the generic assumptions used in the EPA FS.

Figure 2. Comparative Remedy Effectiveness Summary



3.5 Use Practical, Real World Construction Assumptions to Evaluate Short-term Effectiveness

EPA must evaluate the short-term effectiveness of its alternatives, "considering… (1) Short-term risks that might be posed to the community during implementation of an alternative; (2) Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures; (3) Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and (4) Time until protection is achieved." [129] EPA indicates that both short- and long-term impacts should factor into risk-based decision making, stating that "short-term and long-term risks to human health and the environment that may be introduced by implementing each of the remedial alternatives should be estimated and considered in the remedy selection process."[130]

Certain remedies, such as MNR, have "few implementation risks beyond those associated with accompanying monitoring programs,"[131] while more active remedial strategies "can adversely impact existing ecosystems and can remobilize contaminants, resulting in additional risks to humans and the environment."[132] In particular, "[m]onitoring data demonstrate that dredging can have short-term adverse effects, including increased contaminant concentrations in the water, increased contaminant concentrations in the tissues of caged fish adjacent to the dredging activity, and short-term increases in tissue contaminant concentrations in other resident biota."[133] If short-term risks associated with a remedial alternative are neglected when evaluating alternatives, "a biased decision will be reached, and the environment might be damaged with a reduction of risk, or in some cases, risks might be increased due to inappropriate or unnecessary remedial actions."[134] Therefore, "the broad range of risks at a site—before, during, and after application of a risk management option—should be assessed so that the overall risk reduction from application of the option is clear."[135]

The EPA FS inadequately addresses short-term effectiveness, particularly for an FS with remedies that may require decades to complete. Analyzing short-term effectiveness acknowledges and qualitatively identifies impacts to the community, construction workers, and the environment. However, the EPA FS makes no attempt to quantify those

[129] 40 CFR 300.430(a)(9)(iii)(e)
[130] EPA 2005a, pp. 2-14
[131] Magar et al. 2009, pp. 6-12
[132] NRC 2001, p. 7
[133] NRC 2007, p. 6
[134] NRC 2001, p. 171
[135] NRC 2001, p. 10

impacts. For example, the LWG's 2012 Draft FS quantified the risk of worker injury and death and found that Alternative F-r would be expected to cause 51 non-fatal injuries and result in a 21% chance of a fatality.[136] (EPA's Alternatives F and G are even larger than this 2012 Draft FS alternative.) In general, the risk of fatal injury among construction workers of the type who will perform this work is 9.7 fatalities in 100,000 workers, which corresponds to a fatality risk of approximately 10^{-4}. The likelihood of significant injury or fatality is based on actual workplace data compiled by OSHA and is, therefore, far more certain than any of the potential excess cancer and non-cancer risks calculated in the BHHRA, yet the EPA FS does not include an evaluation of the likely short-term injuries and fatalities (e.g., construction related) against potential long-term chemical exposure risks. Although some of the implementation risks can be managed through appropriate and aggressively implemented worker safety programs and health and safety plans, the above injury and fatality statistics mostly involve projects that are in compliance with similar types of safety programs, and thus, risks to workers cannot be eliminated entirely.

As with long-term effectiveness, the short-term effectiveness comparison of alternatives is qualitative in EPA's FS and simply states, "Implementation of Alternative B would have the least impact to the community, workers, and the environment during construction while Alternative G would have the longest impact. However, Alternative B would have the longest impact to the community and environment until RAOs are met, while Alternative G would have the shortest impact." As discussed previously, these qualitative evaluations of time to meet RAOs are unsupported and unlikely to be correct (Figure 1). The FS should examine how increased risks to the community, to workers, and to the environment through resuspension, release, and excess energy use and carbon output balance against the perceived risk reduction associated with each remedy.

For example, EPA should conduct a quantitative dredge release evaluation as part of the short-term effectiveness assessment. Because EPA guidance emphasizes the importance of quantifying dredge releases on a site-specific basis,[137] a dredge release evaluation should incorporate the following components:

- Ensure that dredge release data compiled from other projects are technically valid and relevant to the range of conditions in Portland Harbor.

- Consistent with guidance,[138] EPA should consider a wide range of recent (i.e., last 10 years) dredging projects when compiling information on dredge release rates, not just those that have achieved best-case outcomes.

- To the extent that EPA assumes very rigorous and successful dredging best management practices that successfully constrain dredge release rates, the impact of those assumptions needs to be consistently carried through to estimates of dredging production rates, construction durations, and costs.[139]

3.6 Evaluate Implementability Using Realistic Information when Comparing Remedies

For implementability, the EPA FS indicates in one sentence that more construction is involved as the alternatives progress from B to G; however, there is no actual discussion of the implementability issues involved with any of the alternatives. Using Alternative G as an example, the EPA FS does not discuss the obvious implementability issues associated with such large sediment remediation projects, including the following:

1. Precision dredging involving 6 to 9 million cy of sediment over 18 years with multiple water quality best management practices and requirements

2. Implementing the remedy will require, at a minimum, a continuous 24-hours-a-day/6-days-a-week schedule for the entire multiyear project with no allowable time for related construction operations

[136] USDL 2011
[137] EPA 2005a, Section 6.5.5, p. 6-22
[138] EPA 2005a, Section 6.2, p. 6-3 – 6-4
[139] EPA 2005a, Section 6.5.5, p. 6-22

3. Importing 2.3 million cy capping and cover material

4. Installing and removing large areas of sheetpile or coffer dams partially obstructing the navigation channel

5. Treating (ex situ) a significant percentage of the dredged material using thermal desorption, which has never been applied to a sediment project of this size

6. Instituting permanent regulated navigation areas for 236 acres of caps (11% of the site)

7. Building a dewatering facility and water treatment plant that will operate for nearly the entire construction period

8. Finding a 140-acre shoreline property, which per recent Port of Portland investigations does not exist, nearby and developing it into a large transload facility

9. Managing rail and highway capacity to handle the large volumes of sediment associated with each remedy

All of these concerns are substantial issues regardless of the scale of the remedy and are magnified with increasing remedy size and magnitude.

3.7 Use Accurate Cost Information to Evaluate Cost Effectiveness

In selecting a remedy, EPA must evaluate the cost effectiveness of its remedial alternatives. A Superfund remedy must "provide for cost-effective response,"[140] so long as "it first satisfies the threshold criteria"[141] of protectiveness and compliance with Applicable or Relevant and Appropriate Requirements (ARARs). The NCP deems a remedy "cost-effective if its costs are proportional to its overall effectiveness."[142] The NCP preamble explains, "In analyzing an individual alternative, the decision-maker should compare…the relative magnitude of cost to effectiveness of that alternative. In comparing alternatives to one another, the decision-maker should examine incremental cost differences in relation to incremental differences in effectiveness."[143] Furthermore, "if the difference in effectiveness is small but the difference in cost is very large, a proportional relationship between the alternatives does not exist," and "[t]he more expensive remedy may not be cost-effective."[144]

The information needed to make the cost effectiveness determination during remedy selection comes from the comparative analysis of cost in the FS. This comparative analysis comprises an individual assessment of the alternatives against each criterion and a comparative analysis designed to determine the relative performance of the alternatives and identify major trade-offs (i.e., relative advantages and disadvantages) among them.[145]

EPA guidance reinforces the need to weigh remedial alternative cost against incremental risk reduction, stating that "[t]he evaluation of an alternative's cost effectiveness is usually concerned with the reasonableness of the relationship between the effectiveness afforded by each alternative and its costs when compared to other available options."[146] A "[c]areful evaluation of site risks…help[s] to prevent implementation of costly remediation programs that may not be warranted."[147] To determine the relative cost effectiveness of a remedial alternative, an accurate analysis of its cost is required. According to the NCP, the cost estimate should be comprehensive and include "(1) Capital costs, including both direct and indirect costs (2) Annual operations and maintenance costs; and (3) Net present value of capital and O&M costs."[148] Additionally, in *Contaminated Sediments Remediation: Remedy Selection for Contaminated Sediments*, the Interstate Technology Regulatory Council (ITRC) indicates that "[m]any

[140] 42 U.S.C. 9621
[141] 40 CFR 300.430(f)(1)(ii)(D)
[142] 40 CFR 300.430(f)(1)(ii)(D)
[143] Preamble, 55 FR 8728
[144] Preamble, 55 FR 8728
[145] NCP, 1990 @ 55 FR 8719
[146] EPA 2005a, pp. 7-3
[147] EPA 1996a, p. 2
[148] 40 CFR 300.430 (e)(9)(iii)(G)

factors beyond the cost of the technology being evaluated must be considered, such as material costs, transportation costs, storage costs, and monitoring costs."[149]

EPA's *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* describes data sources that should be used to generate cost estimates, which include "cost curves, generic unit costs, vendor information, standard cost estimating guides, historical cost data, and estimates for similar projects, as modified for the specific site."[150] Overall, properly evaluating the cost and cost effectiveness of each remedial alternative is crucial to ensuring compliance with CERCLA and NCP directives.

EPA's cost estimates in the FS are based on unrealistic assumptions, omit critical cost components, and contain errors. For example,

- EPA provides virtually no details on how quantities (e.g., volumes dredged, acres capped, volumes of import material) are determined for each alternative. For example, based on the amount of information available, the LWG has commented that the volumes for dredging appear substantially underestimated for all alternatives

- Appendix G cost estimates includes "periodic costs" between $337-million and $977-million but with little detail provided on how those values were generated

- No supporting information for estimating the quantities and cost of riverbank treatment and disposal between $100 and $600 per ton

- Unclear whether non-RCRA, non-PTW remediation waste would be treated prior to disposal[151]

- Underestimated costs for a trans-load facility

- No costs assigned for dewater treatment described in the main text

- Inconsistent mitigation cost values

- Use of the 7% discount rate at a site at which EPA has named multiple government agencies as PRPs, acknowledges that many non-public PRPs will rely on insurance proceeds to fund remedy implementation, and may require performing parties to provide financial assurance using a discount rate as low as the treasury rate (1.4% in 2015)[152]

- No consideration of cost impacts related to extensive and innovative dredge and dredge BMP methods contemplated by the FS

- Some individual quantities are inconsistent across text and tables by as much as 100% (e.g., total construction acres, ex situ treatment volumes), calling into question EPA's assessment that the required cost accuracy of +50% to -30% range was met.

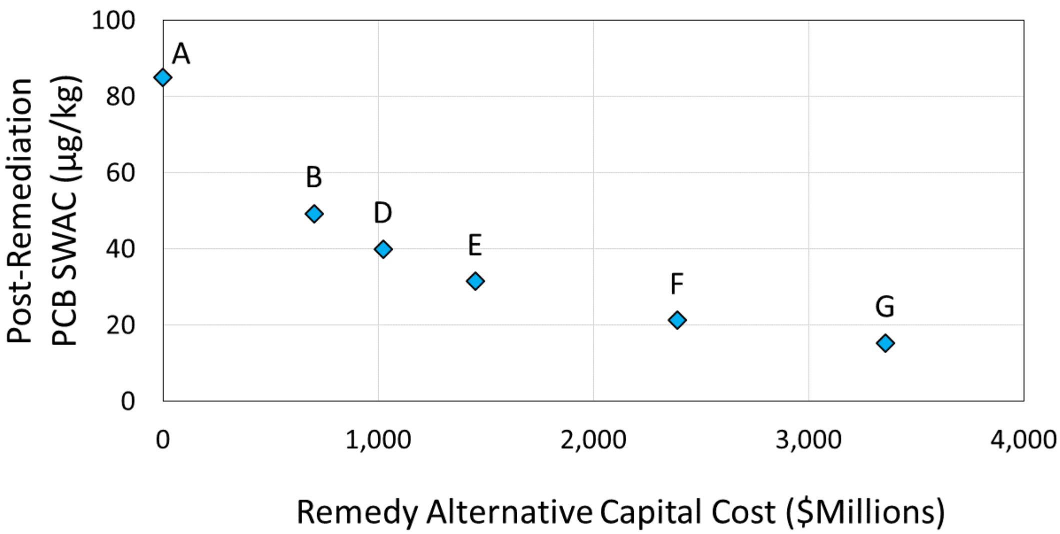
In addition, costs must be broken down on an SMA-basis so that EPA can evaluate the cost effectiveness of its selected remedy in areas of the site that pose more or less risk and so that responsible parties have the information

[149] ITRC 2014, p. 56
[150] EPA 2000c, p. 2-5
[151] Although RCRA land disposal restrictions apply only to RCRA hazardous waste EPA appears to use RCRA land disposal restriction values to identify large areas of non-RCRA remediation waste that must be treated prior to disposal if excavated or dredged. Treatment of non-hazardous remediation wastes to LDRs has not been (and should not be) identified as an ARAR for the site, and so it is unclear on what EPA bases this requirement. However, EPA's cost assumptions do not appear to include any costs associated with treatment to LDRs, and so it is therefore impossible for EPA to evaluate whether the cost of treatment and, potentially, disposal at a Subtitle C facility of thousands of cubic yards of material that meets the acceptance criteria for Subtitle D disposal is justified by any incremental reduction in risk.
[152] EPA 2015c

necessary to negotiate with EPA toward consent decrees to implement EPA's remedy through a performance settlement.

Figure 3 shows the cost effectiveness for each remedial alternative by plotting the EPA FS post-construction site-wide PCB SWACs with the EPA costs to implement each alternative using PCBs as an example. More cost-effective alternatives are those that achieve the largest decrease in SWAC (y-axis), given the smallest increase in cost (x-axis). Alternative B results in the largest decrease in PCB SWAC concentration for every dollar spent. The remaining alternatives yield only modest decreases in PCB concentrations over rapidly increasing costs to implement.

Figure 3. Cost Effectiveness Evaluation of Remedial Alternatives A, B, D, E, F, and G



EPA's FS provides time-zero post-remediation SWAC concentrations and related residual risk estimates as the only metric that can serve as a proxy for risk reduction. As noted above, this residual risk assessment is inconsistent with the BLRAs in multiple respects and results in risk estimates for the no action alternative that are usually substantially higher than found in the BLRAs. All of this indicates that EPA's residual risk assessment does not accurately describe the actual risk reductions of any of the alternatives. A more thorough cost-effectiveness evaluation should be conducted that explicitly focuses on accurate and appropriate estimates of risk reduction. Figure 3 shows the only quantitative information on risk reduction provided in the EPA FS.

Selection of any of the dredging-focused higher cost remedies under consideration in the absence of material additional risk reduction relative to the significant incremental cost would be inconsistent with CERCLA, the NCP, and the Sediment Guidance, which all expressly require that remedies be cost-effective.[153] In the NCP, cost effectiveness is defined as "costs [that] are proportional to [a remedy's] overall effectiveness." As noted in EPA's FS Table 4.3-2, all of the remedial alternatives identified are ranked as "+" (protective). Consequently, the high cost remedial alternatives in the EPA FS do not provide material incremental risk reduction proportional to their significant incremental costs and should not be selected.

3.8 Revise the FS Evaluations

Overall, the EPA FS remedy evaluation has been developed largely on a qualitative basis. Each alternative should include all reasonably anticipated elements required to perform that alternative and, where available, should be

[153] 42 U.S.C. §9621(a); 40 CFR §300.430(f)(1)(ii)(D); EPA 2005a, p. 7-3

based on costs and durations seen on recent projects to perform the same or similar sediment remediation work. The preferred remedial alternative should be cost-effective and should demonstrate how its costs are proportional to its effectiveness in reducing risk. Specific quantitative analyses that should be included in the evaluation of balancing criteria but were not included in the EPA FS are listed below.[154]

- Estimate residual risks following remedy construction that:
  - Is consistent with the baseline risk assessment approaches and results;
  - Incorporates the most recent sediment and fish tissue data that most realistically reflect current conditions at the site; and
  - Relies on realistic estimates of construction durations and natural recovery processes.

- Quantify short-term remedy implementation risks that:
  - Include estimates of realistic short-term environmental impacts (e.g., dredge releases) that take into account the full range of recent case studies;
  - Quantify potential risks to construction workers and the general public from the sediment removal, transportation, and treatment; and
  - Estimates community impacts from long-term dredging and capping operations on the river (e.g., recreational uses, light, noise, emissions, etc.).

- Consider the feasibility and implementability of the remedial alternatives including, but not limited to:
  - Identification and staging of sediment transload and water and sediment treatment facilities;
  - Evaluation of whether dredge production rates included in the EPA FS can be maintained over the entire project schedule (e.g., contingencies for weather);
  - Community acceptance;
  - Obstructions to the navigation channel;
  - Thermal treatment of millions of cubic yards of sediment; and
  - The incremental reductions in risk based on increasing remedy footprints.

- Quantify the cost to implement each alternative, including an evaluation of the incremental reductions in risk based on increasing implementation costs.

4. Maximize Flexibility in Remedy Design and Implementation

The Portland Harbor Superfund Site is large and includes an extraordinarily complex array of chemicals, sources, and physical environments. Developing a single FS for the entire site requires simplifying assumptions that create disparities in applicability and/or appropriateness of the FS technology assignments among the varied cleanup areas within the site. Other large sites (including the Housatonic, Lower Passaic, and Fox rivers) have been divided into segments, sometimes OUs, because of similar varied conditions.

EPA has developed a set of overly prescriptive rules for assigning technologies for cleanup and disposal derived from simplifying assumptions that unnecessarily narrow the scope of potential cleanup or disposal options among the alternatives. A broader range of options and technology combinations would have resulted if separate RI/FS projects would have been implemented for the major SMAs.[155] If EPA moves to remedy selection now, the Proposed Plan and ROD for Portland Harbor must include flexibility for site-specific (e.g., SMA-specific) decisions during design and implementation. Because "there is no presumptive remedy for any contaminated sediment site, regardless of the contaminant or level of risk,"[156] EPA stresses that "[i]t is important to remain flexible when evaluating sediment alternatives and when considering approaches that at first may not appear the most appropriate for a given environment."[157] NRC guidance stresses that the "management of contaminated [sediment sites] needs to

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[154] A more comprehensive discussion of information and analyses that should be included in the FS can be found in the LWG's *List of Significant Issues on EPA Feasibility Study Section 3 and 4* (LWG 2015c) and *Additional Comments on EPA's Revised FS Section 3 and 4* (LWG 2015d).
[155] See, e.g., the 2012 Draft EE/CA for the Gasco Sediment Site.
[156] EPA 2005a, p. 7-16
[157] EPA 2005a, p. 7-5

embrace a more flexible and adaptive approach to accommodate unanticipated factors, new knowledge, technology changes, and results of field pilot tests."[158]

While "a flexible risk-based approach"[159] is an important consideration during the FS process, it also can be incorporated into decision documents for Superfund sites. EPA's *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents* states that the discussion of the selected remedy "should mention that the remedy may change somewhat as a result of the remedial design and construction processes."[160] For example, in the Fox River and Green Bay ROD for OU1 and OU2, in situ capping was selected as a "contingent remedy" to supplement sediment removal in certain areas. By including this option, EPA "sought to create the ROD flexibility described in the Principles memorandum and the NCP. Such flexibility [would] allow for 'mid-course corrections' in the selected remedy based on what is learned from remedial activities undertaken early in the process."[161]

Also, the remedy design and remedial action processes should respond to data collected after issuing decision documents. "An iterative approach to site investigation and remedy implementation that provides the opportunity to respond to new information and conditions throughout the lifecycle of a site,"[162] is necessary "in remedy selection and implementation at large, complex [sites]."[163] Moreover, by using flexible approaches "[d]uring remedy implementation, EPA can evaluate remedy performance and modify operations to more efficiently attain RAOs."[164] Incorporating the principles of flexibility throughout remedy selection, design, and implementation will support an efficient cleanup.

4.1 Allow Flexibility to Refine and Adjust Technologies and Process Options During Remedial Design

The EPA FS relies on broad assumptions and generalizations to complete its analysis of remedial alternatives. Whereas such assumptions may have facilitated the evaluation of alternatives, they should not be used in the Proposed Plan or ROD as prescriptive requirements for remedial design/remedial action (RD/RA). Instead, flexibility should be integrated into the Proposed Plan and ROD to allow for the following changes:

- The FS, Proposed Plan, and ROD should recognize that additional site data will be collected during RD/RA, and they should allow for the appropriate use of these data in RD/RA to refine and implement cost-effective sediment remedies. As needed, refinement decisions (e.g., technology assignments based on changing conditions) could be based on criteria set forth in the FS, Proposed Plan, and ROD.

- Even if new data are not available, the FS, Proposed Plan, and ROD should include text that clearly articulates how flexibility in RD/RA will be utilized to make appropriate decisions to cost-effectively achieve risk reduction on an area-by-area or site-wide basis (including refinement of areas and volumes of active remediation, and the site-specific technologies employed, as appropriate).

4.2 Allow Flexibility When Delineating SMAs during RD/RA

It is unclear how the remedial design process will be implemented, but it is assumed that remedial designs will be prepared to address discrete subareas of the overall site. Each subarea design will involve more site-specific engineering assessments even in the absence of any new data. Further, each subarea design will likely require collection of substantially more site-specific, detailed information than is currently available. These site-specific engineering assessments and additional site-specific information will be used to refine the sediment remedy beyond the broad assumptions and generalizations in the EPA FS. New information may include improved and more up-to-date delineation of SMA footprints and COC deposit depths, characterization of geotechnical conditions,

[158] NRC 2007 p. 249
[159] EPA 2002b, p. 5
[160] EPA 1999, p. 6-40
[161] EPA 2002d, p. 1-8
[162] EPA's *Superfund Remedial Program Review Action Plan* (EPA 2013c) p. 8
[163] NRC 2007, p. 14
[164] EPA 2013c, p. 9

hydrodynamics analyses, assessment of current and expected future water-dependent and shoreline uses, and analysis of shoreline and navigational infrastructure.

SMAs are expected to change because of natural sediment transport and sedimentation processes in the river. Based on lines of evidence presented in LWG's 2012 Draft FS,[165] as well as subsequently collected data (primarily 2011/2012 PCB data for smallmouth bass whole-body fish tissue, 2014 sedimentation bathymetry data, and 2014 site-wide sediment PCB data), natural recovery of COCs in surface sediments is a known ongoing process occurring within the site. SMAs delineated using the RALs defined in the EPA FS will change over time as natural recovery processes cause some areas to decline below those RALs. The revised FS should continue to recognize, and the Proposed Plan and ROD should allow for, changes in SMAs and remedial technology and process option selections in RD/RA based on the most recent and comprehensive data available relevant to ongoing natural recovery. We acknowledge the inherent uncertainties in predicting MNR; such uncertainties can be managed through long-term monitoring and careful assessment of conditions.

4.3 Separate the Site into Operable Units Focused on the Most Important SMAs

Separating the Portland Harbor Superfund Site into multiple OUs could facilitate a more effective and timely remediation and risk reduction effort. There is significant precedence for this approach, and it is well documented in guidance. "The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site."[166] In addition, "[s]ites should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of total site cleanup."[167] EPA's ROD guidance states that "the cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site" and "[d]ue to the fact that many Superfund sites are complex and have multiple contamination problems or areas, they are generally divided into several operable units for the purpose of managing the site-wide response action."[168]

Given the large areal extent of the Portland Harbor, heterogeneous nature of sediment contamination and physical characteristics of this site, breaking the site into OUs and implementing the remedies in a systematic manner could be the most appropriate approach for timely risk reduction and controlling sources of contamination. OUs will allow EPA to identify and evaluate remedy technologies during remedy design by taking into account a more detailed evaluation and engineering assessments of existing information, new baseline conditions, the physical characteristics of the sediments, the hydrodynamic conditions, and the types of exposures mitigated (e.g., high concentration areas) in particular OUs. Remediation in high priority areas can then be expedited by enabling a phased remediation approach followed by a period of monitoring in order to evaluate the effectiveness of these remedial actions, consistent with EPA guidance.[169] Finally, OUs will not preclude the realization of cost efficiencies through the sharing of staging facilities and equipment as remedy construction shifts from one OU to another. Overall, dividing the site into OUs can facilitate management of the Portland Harbor site by allowing for a cost effective, manageable, and implementable remedy.

Other Superfund sites provide precedent for using OUs to address similar issues of site complexity and remedy implementation. For example, the Fox River (Region 5) site was divided into 5 OUs on the basis of physical features and historical data,[170] and the Housatonic and Hudson Rivers have been divided into units or work areas for phased approaches to remediation.[171] Similarly, the Harbor Island and Wyckoff-Eagle Harbor NPL sites in Region 10 were divided into separate in-water OUs. Harbor Island was split into multiple OUs because EPA

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[165] Anchor QEA et al. 2012
[166] 40 CFR 300.5
[167] 40 CFR 300.430(a)(1)(ii)(A)
[168] EPA 1999
[169] EPA 2002b
[170] EPA 2002d
[171] EPA 2002c

determined it "could be managed more efficiently,"[172] and Wyckoff-Eagle Harbor was divided into OUs because of differences in "environmental media, sources of contamination, public accessibility, enforcement strategies, and environmental risks in different areas of the…site."[173]

4.4 Incorporate Flexibility into the ROD

Flexibility should be integrated into the Proposed Plan and ROD to allow for the following changes:

- The FS, Proposed Plan, and ROD should recognize that the site has changed considerably and that additional site data will be collected during RD/RA, and they should allow for the appropriate use of these data in RD/RA to refine and implement cost-effective sediment remedies. As needed, refinement decisions (e.g., technology assignments based on changing conditions) could be based on criteria set forth in the FS, Proposed Plan, and ROD. (We acknowledge that the EPA FS already recognizes that site conditions may change due to ongoing natural recovery processes.)

- The FS, Proposed Plan, and ROD should incorporate flexibility into technology assignments based on more site-specific engineering assessments, even if new data are not available. The LWG recognizes that the FS technology evaluation process requires an understanding of technology options and requires the assignment of technologies to specific areas. However, it is equally important to recognize that these assignments are made with limited detailed information on specific areas and that much more site-specific engineering evaluations will be conducted and knowledge will be acquired during design.

- EPA should consider the use of contingent remedies to address site-wide risks as well as to address uncertainties within SMAs. Where significant uncertainty about the effectiveness of a technology at a particular SMA or the time frame to attain cleanup levels across an exposure area remains at the time of the ROD, use of contingent remedies would allow EPA administrative and engineering flexibility to adjust to conditions at the site during remedy implementation. For example, the contingent remedy for the Fox River, provides:

  > Contingent remedies…
  >
  > - [Shall provide] the same level of protection to human health and the environment as the selected remedy…
  > - …shall not take more time to implement than the selected remedy
  > - …shall comply with all necessary regulatory, administrative and technical requirements…[174]

  Contingent remedies have been used successfully at other Oregon sites, including at the McCormick and Baxter Superfund Site, where the contingent remedy for groundwater required installation of a physical barrier if NAPL was not controlled hydraulically or if the barrier proved more cost effective.[175]

- The FS, Proposed Plan, and ROD should clearly articulate how flexibility in RD/RA will be used to make appropriate remedy modifications to cost-effectively achieve risk reduction on an area-by-area or site-wide basis (including modifications to areas and volumes of active remediation, and the site-specific technologies employed, as appropriate).

Incorporating the principles of flexibility throughout remedy selection, design, and implementation will support an efficient cleanup process for the site.

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[172] EPA 1993b, p. 2
[173] EPA 1996b, p. 6
[174] EPA 2002d
[175] EPA 2006 ROD for McCormick and Baxter

5. **LWG Recommended Remedy**

If EPA follows the recommended approach set out by the LWG in this letter, including reasonable PRGs based on appropriate risk management, the resulting remedy would have the following characteristics:

- RALs that are appropriately applied to surface sediments consistent with the methods and results of the BLRAs and that focus on active remediation of the highest contaminant concentrations:
  - PCB RAL of 1,000 µg/kg
  - DDE RAL of 1,000 µg/kg
  - cPAH (as BaPEq) RAL of 20,000 µg/kg
  - Designated CBRAs consistent with the multiple lines of evidence evaluation of benthic toxicity in the BERA
- Flexible technology assignments assigned to SMAs or OUs, with an appropriate balance of removal and in-place technologies at the harbor-wide scale (e.g., capping, in situ treatment, and EMNR). We anticipate this will equate to approximately 50% dredging and 50% in-place technologies (by site-wide acreage). Technology assignment must take into account that the longer it takes to implement the remedy, the longer the impact to the river and the fish, and the longer it takes the system to recover.
- No identified PTW beyond management of identified "substantial product" at the Gasco Sediment Site consistent with 2009 Gasco Order.
- Appropriate application of in situ and ex situ treatment of a significant volume of materials at the site through application of the above appropriate RALs and technology assignments.
- Use of OUs to manage the site based on the localized chemical and physical characteristics.
- Exclude riverbank soils remedies (leaving those to be designed and implemented through either DEQ upland source control program or future sediment remedial designs).
- Refinement of technology process options in remedial design (e.g., types of dredging and dredge BMPs, types of treatment, and habitat and flood mitigation methods).

Figure 1 shows that short- and long-term outcomes associated with various sets of RALs on site-wide PCB SWACs are very similar. Charting the recovery of other COCs would result in similar curves. Therefore, consistent with EPA's FS and the analysis summarized in Figure 1, such an alternative would be protective and compliant with ARARs and would be a cost-effective, implementable remedy. The areal extent of SMAs developed under this alternative would be defined based upon evaluation of data collected in remedial design, and the general balance of technology assignments would be refined or modified during remedial design as appropriate based upon site-specific engineering evaluations and design data. The LWG believes this remedy could be implemented through settlement within a reasonable time frame following the ROD.

Conclusion

The LWG appreciates the opportunity to comment to the NRRB and looks forward to the NRRB's feedback. All of EPA's alternatives meet the threshold criterion of protectiveness. As shown by Figure 1, the LWG's recommended remedy is also protective. All EPA alternatives and the LWG-recommended remedy achieve nearly indistinguishable reductions in risk in relatively the same amount of time. Therefore, active remedies should focus on discrete areas of higher sediment concentration that present the most significant risks, as identified in the risk assessments.

By addressing the significant technical issues with the EPA FS and applying sound risk management principles to baseline risk assessment outputs, EPA could revise the FS to provide a more solid foundation for selection of a remedy:

- The FS should prioritize the most significant and pervasive risks and align remedy selection with sound risk management principles. The sediment remedy should be focused on measurable and meaningful reductions in risk, particularly related to fish consumption.

- Remedies should be transparently aligned with risks identified in the baseline risk assessment.

- The selected remedy should consider other measures to further reduce fish consumption risks. No sediment remedy under consideration will entirely eliminate risk from fish consumption or eliminate the need for fish advisories in the main stem Willamette River, due to regional (watershed) sources of contamination.

- Quantitative analyses must underlie remedy evaluation and selection. Without a coherent CSM and a quantitative method to evaluate effectiveness, EPA's FS cannot present a sufficient evaluation of the alternatives' protectiveness or a reliable foundation for remedy selection. Existing tools should be incorporated into the FS.

- EPA should reassess its approach to PTW to ensure consistency with both EPA guidance and precedence at other sites. Inappropriately designating PTW in vast areas of the Portland Harbor significantly increases remedy cost without any resulting risk reduction, and treatment without demonstrated risk reduction is inconsistent with the NCP and CERCLA guidance.

- EPA should improve evaluation of technologies, construction outcomes and impacts, implementation issues, and their associated costs. By improving its consideration of technology effectiveness for specific SMAs, construction impacts, effectiveness, implementation details, and realistic cost assumptions, EPA's FS can enable more robust, quantitative evaluation of remedial alternatives.

- Flexibility in remedial design will enable risk-based cleanup goals to be achieved in a timely, effective, and cost-efficient manner. EPA should accommodate flexibility for site-specific engineering assessments (e.g., OU or smaller), including the exact technologies used and the areas and volumes requiring active cleanup. In addition, contingent remedies can help EPA manage the inherent uncertainties with such a large site.

By following the recommended approach set out by the LWG in this letter, including reasonable PRGs based on appropriate risk management, a Portland Harbor remedy would look very much like the LWG's recommended remedy. The LWG's recommended remedy is protective, implementable, cost-effective, and most likely to lead to a consent decree for performance. The LWG appreciates the NRRB's consideration of these comments and respectfully requests that the NRRB consider the LWG's recommended remedy in its comments on the Portland Harbor site.

Sincerely,

The Lower Willamette Group

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